TELE-TECH

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ELECTRONIC INDUSTRIES

FEBRUARY, 1947

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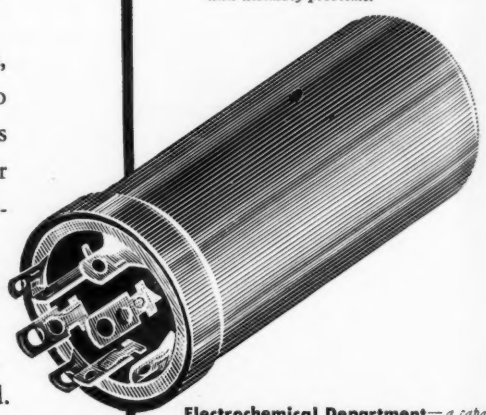

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O. H. CALDWELL, EDITOR ★ M. CLEMENTS, PUBLISHER ★ 480 LEXINGTON AVE., NEW YORK (17), N. Y.

Engineers and Businessmen

Recent engineering get-togethers have shown progress in encouraging mutual understanding between radio engineers and the business executives of the industry. Appropriately a cue for the move came from a recent address by Edgar Kobak, president of Mutual Broadcasting System, himself a Georgia Tech engineer turned business leader.

President Kobak has long devoted much time to encouraging respect and appreciation for engineers on the part of business. "Also," he adds, "I believe this appreciation can be carried farther; and should be supplemented by a reciprocal feeling on the part of the engineer for the work of the businessman. I can see the need for a closer meeting of their minds—for such meeting is bound to strike sparks from which will come more and more progress."

Diathermy Interference

A band centered at 27.32 megacycles (270 kc wide) seems to be the medical-diathermy frequency favored by the equipment manufacturers, in recent discussions with FCC. However, the Commission was told that experiments are also being carried out at 500, 1000, 3000, 6000 and 9000 megacycles, and that, later, requests may be made for assignments at these frequencies.

Newer diathermy machines are shielded in metal cabinets, but this shielding is not wholly effective because unshielded leads are used to connect the machine with the electrodes applied to the patient. Medical-diathermy makers are also protesting at the one-half of one per cent frequency tolerance which FCC is insisting upon, declaring that they can meet this only with crystal control and a 40 to 50% increase in selling price. Medical people also complain about the closer tolerances demanded of doctors' machines compared with tolerances required of industrial installations. Explanation is the widespread location of medical machines in physicians' offices in residence neighborhoods, where injury can be done to both FM and TV in surrounding homes.

Trans-Atlantic Video

As we near the sunspot-cycle conditions which make for long-distance transmission in the short-wave channels, long-distance propagation in the 40-mc band is becoming more pronounced. Already at the FCC listening post at Laurel, Md., the sound signals of the London television station on 45 mc (41.5 mc sound) and the Paris station (46.1 mc video) are reported being picked up frequently.

Any reader who has a television receiver working on these frequencies, may even be able to pick up London or Paris TV pictures any day now,—repeating the experience of Long Island RCA researchers during the last corresponding solar period in the 1930's.

PICAO's Job

The PICAO conference, (See page 40) its efforts crowned with success, has now become history. What of its future?

Until the next meeting, two or three years from now, the governing body, the Interim Council headed by Dr. Edward P. Warner will have to get all nations concerned to accept the decisions already reached.

It will also want to keep records of installations of adopted systems as they are made and in general speed up implementation of the program.

In other words PICAO has decided what to do. The big job ahead is to get everyone to do it!

Next Month — TELE-TECH's I.R.E. SHOW NUMBER — **March TELE-TECH**

With the I.R.E. Show being held right in our own building, the Grand Central Palace, 480 Lexington Ave., New York 17, N. Y. March 3 to 7, the editors and publishers of Tele-Tech are planning to make the March issue notable as the I.R.E. Show Number, covering tele-communications for radio, television, railroads and aviation, with special show coverage and extra distribution from our booth at the Show. And incidentally, readers are invited, when visiting the Show, to give the editors of Tele-Tech a call in person, either at our booth, or in our offices on the sixth floor of the Show Building, Grand Central Palace. We'll be delighted to see you.

Automatic Gain Adjusting Amplifier

By DONALD E. MAXWELL, General Engineering Dept.
Columbia Broadcasting System, Inc., New York

Engineering and design of unusual unit providing short attack time to prevent splatter, low compression level and elimination of pumping

IN view of the limitations of many of the commercially available peak-limiting amplifiers, the General Engineering Department of the Columbia Broadcasting System recently completed a two-fold program of improvement; first, the development of special measuring equipment for accurately analyzing the dynamic performance of peak-limiting amplifiers; and second, the development of a new type of peak-limiting amplifier without the shortcomings of a dynamic nature listed herein.

• Although peak-limiting amplifiers have become an indispensable part of almost all radio broadcasting and recording systems, many of the types which are commercially available leave much to be desired from the standpoint of dynamic performance.

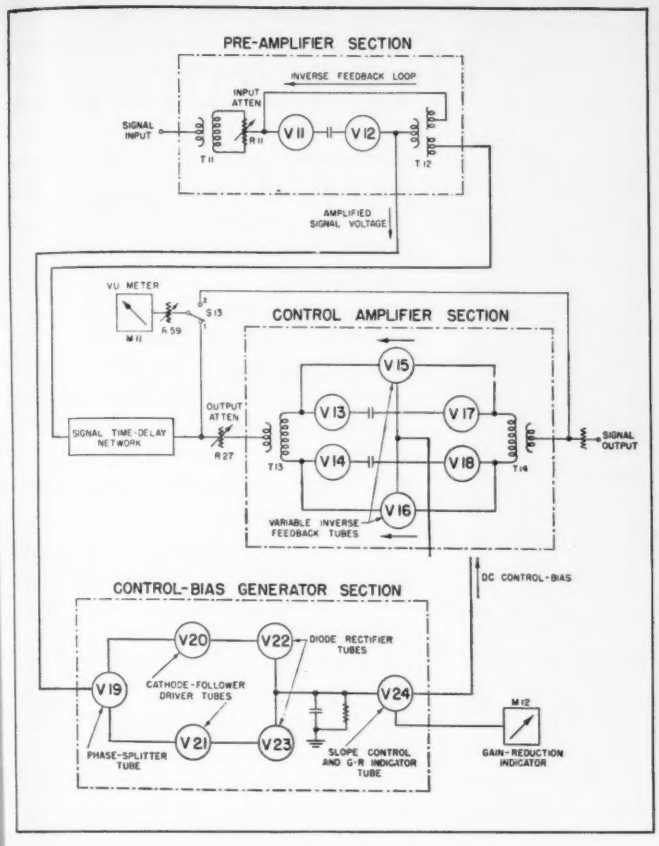
Among the shortcomings of these amplifiers are (a) an attack time insufficiently short to prevent sideband "splatter" of associated broadcasting transmitters; (b) audible "thumps" when gain-reducing action occurs—gain-reduction in excess of that demanded by the actuating signal peak (overcontrol); (c) low compression ratio, and, (d) when using several decibels of peak-limiting, objectionable amplitude "pumping" of the program level.

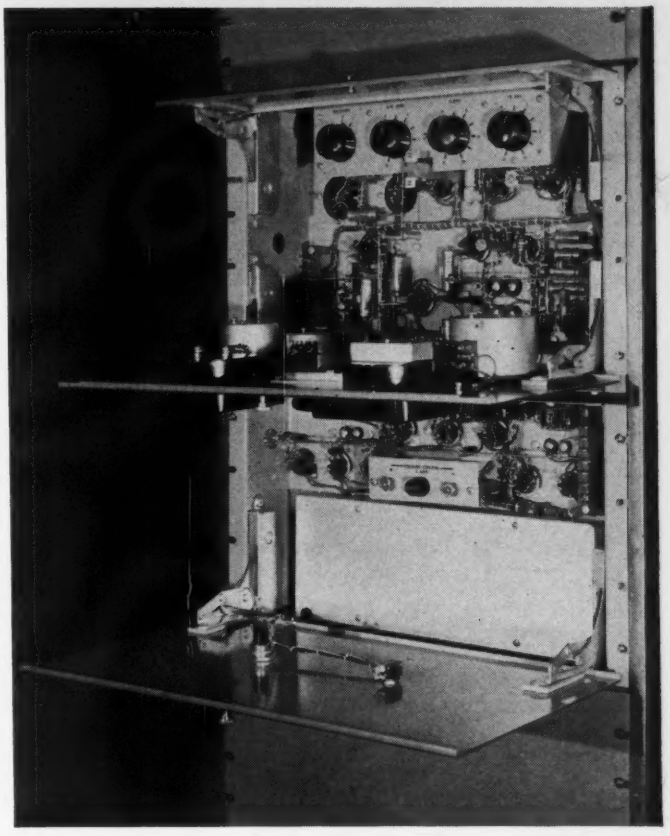
Most of these characteristics do not lend themselves to evaluation and measurement by any of the steady-state sine-wave tests commonly applied to audio frequency amplifying equipment. Furthermore, in the past, the various manufacturers' specifications on peak-limiting amplifiers have usually included very little information on the dynamic performance of their amplifiers.

It is not within the scope of this paper to describe in detail the measuring equipment and technic that was developed to make analyses of peak-limiting amplifier performance. Briefly, however, the technic consists of periodically applying electronically - controlled, sinusoidal signal peaks to the input terminals of the peak-limiting amplifier undergoing analysis, synchronizing the sweep circuits of an oscilloscope with the applied input peaks, and visually observing the resulting output voltage of the amplifier on the screen of the oscilloscope.

This action is regularly repetitive at a rate slow enough to allow complete gain recovery of the amplifier between peaks, but sufficiently fast to permit continuous visual observation of the transient phenomena without the necessity of photographic processes. By the use of this system the various transient phenomena accompanying the gain-reducing action of the amplifier can be observed cycle by cycle of the applied sine-wave peak. Such effects as transient amplitude-overshoot due to slow attack

View of front panel of the gain - adjusting amplifier in its standard cabinet with the author at the controls





Functional block diagram of the automatic gain adjusting amplifier, and a view of the complete unit with the front panels opened

time, control current surges (thump), waveform distortion, over-control, and dynamic instability can be studied in as great detail as desired.

Using this measurement technic, a study was made of the dynamic performance of a number of types of commercially-available peak-limiting amplifiers. In most instances considerable need for improvement was indicated. This same measurement technic aided materially in the final development and test of the new type of peak-limiting amplifier to be described in this paper.

More than a year and a half ago E. E. Schroeder of the CBS-Chicago (WBBM) technical staff invented and developed a new type of peak-limiting amplifier. This work was done under the direction of J. J. Beloungy, then chief engineer of WBBM and now chief engineer of WCCO. Schroeder's amplifier, which has been in operation at the WBBM transmitter since the summer of 1945, has given very greatly improved performance as compared to any peak-limiting amplifiers previously used at WBBM.

Measurements of the dynamic performance of this amplifier were made, using the special transient-analyzing equipment mentioned above. These measurements showed conclusively that the WBBM amplifier has dynamic characteristics vastly superior to any peak-limiting amplifiers previously analyzed with this equipment.

Equipment Available

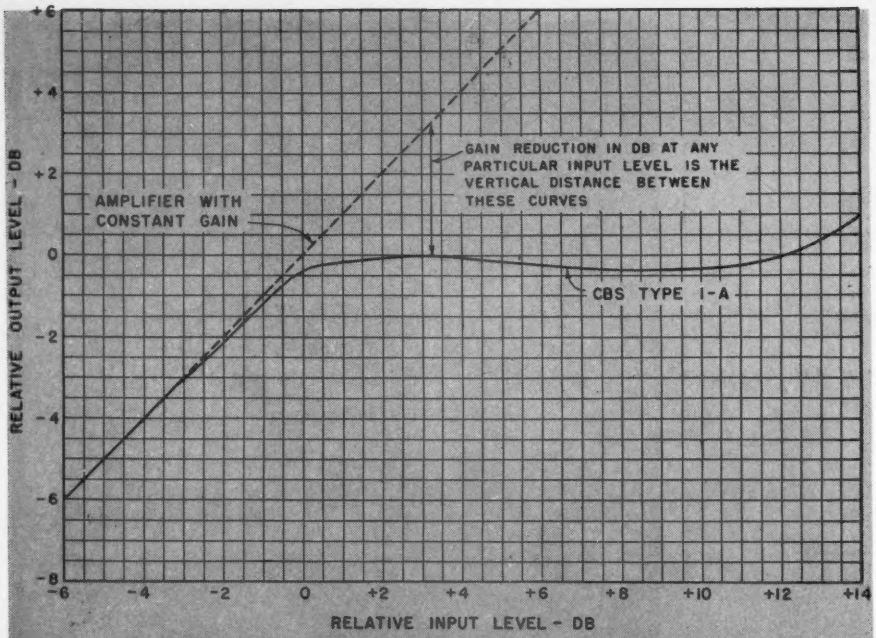
Steps, therefore, were taken to make this superior amplifier standard equipment at all Columbia-owned stations. The amplifier, in a completely repackaged version of the original unit, plus some circuit modifications, has been designated the CBS Type 1-A automatic gain-adjusting amplifier. The repackaging of the prototype unit was accomplished by the combined efforts of the CBS General Engineering Department and the General Electric Co., which latter organization is currently manufacturing these amplifiers for CBS. A General Electric version of the CBS 1-A Amplifier shortly will be available to the industry as a whole, through regular commercial channels. The General Electric unit will be known as the G-E type BA-5-A limiting amplifier.

The CBS 1-A amplifier has several outstanding performance characteristics which distinguish it from previously-available peak-limiting amplifiers:

1. Essentially zero attack time.—Not a single program peak can appreciably exceed the predetermined maximum output level. Therefore, even momentary overmodulation of an associated transmitter is prevented within the rated range of peak levels accepted by the CBS 1-A amplifier. While fast attack time is a nominal feature of all peak-limiting amplifiers, the actual attack time of many commercially-available units is too long to prevent a considerable number of program peaks from being passed at amplitudes considerably in excess of the desired maximum. The CBS 1-A effectively "catches" *all* the program peaks.

2. Unusually-low, transient waveform distortion.—The gain-reducing action of the CBS 1-A amplifier is such that the waveform of high-amplitude transient peaks is reproduced more faithfully than in ordinary peak limiting amplifiers.

3. Very high compression ratio above threshold of gain-reducing action.—This permits a higher average modulation level without



Curves of relative output and input levels of automatic gain adjusting amplifier

overmodulation than previously-available peak-limiting amplifiers.

4. Very high signal-to-"thump" ratio.—Circuit design is such that motorboating or other forms of instability are impossible. The circuit has an inherent, unusually high ratio of signal voltage to control voltage, greatly minimizing audible "thump" when gain-reducing action takes place.

5. Recovery time an automatic function of program material.—A special circuit minimizes objectionable "pumping" of program level, a dynamic shortcoming of ordinary peak-limiting amplifiers. Automatic gain-reducing action will therefore have a less noticeable effect on the dynamic range of the program material.

6. Very low distortion at all degrees of gain-reduction.—Distortion actually becomes **lower** as the input signal level increases above the threshold value, due to the inverse-feedback gain-reducing circuit.

7. Standard VU meter and associated controls on front panel permit continuous visual monitoring of program level either ahead or after the point where gain-control is effected. This feature permits, for example, a transmitter operator to check program peaks with his studio master control room. In ordinary peak-limiting amplifiers the VU meter is connected after the point where gain-reduction occurs, and there is therefore no correlation between the peak readings of the VU meter at the transmitter location with those at the studio.

In addition to these unusual features, the CBS 1-A amplifier provides a high standard of steady-state performance. The signal-to-noise ratio is 70 db, the harmonic distortion is less than 1% from 50 to 15,000 cps, and the frequency response is within plus or minus 1 db from 30 to 15,000 cps. Regulated power supplies maintain complete stability of performance characteristics over a wide range of line voltage variations.

Operating Reliability

Considerable care has been taken to insure a high degree of operational reliability. Highest-quality components of conservative ratings have been employed throughout. A large-size dc meter and associated switch on the front panel not only show automatic gain-reduction, but check tube currents and power supply voltages.

The CBS Type 1-A automatic gain-adjusting amplifier has a unique combination of circuits to achieve its outstanding performance. The block diagram shows that the amplifier unit consists of three functionally-distinct sections, the preamplifier, the control amplifier, and the control-bias generator. A signal time-delay network is connected between the preamplifier and control amplifier sections.

The preamplifier serves to raise the input signal to a suitable level for feeding the control amplifier and control bias generator sections. It also provides a 600-ohm circuit with sufficient level to operate the VU meter and M11 ahead of the control amplifier. Thus, when the switch S13 is thrown to position 1, the VU meter will indicate program peaks identically, with the VU meter at a remote originating source, thus facilitating program level checking. The preamplifier is relatively conventional in design, consisting of two audio stages with inverse feedback around both stages.

Signal voltage from the preamplifier is fed to the control bias generator section, which develops the dc bias required for automatic gain-reduction. Thus, the control bias is a function of the input signal voltage of the CBS 1-A amplifier. The control bias generator utilizes power-type driver and rectifier tubes in very low impedance circuits, resulting in extremely fast development of the automatic control voltage.

Another unique circuit-design feature is the use of a time-delay network in the signal channel just ahead of the input to the control-amplifier section. This network acts to delay the signal reaching these stages until the control bias generator circuits have had time to generate the required dc control bias. As a result, not a single program peak can even momentarily cause the output level of the control amplifier to exceed the predetermined maximum value.

Gain Reducing Action

Gain-reducing action is effected in the control amplifier section by automatic variation of the grid bias of two feedback tubes, V15 and V16, which act as variable inverse feedback resistances. The circuits in the control amplifier provide an unusually high ratio of signal-voltage to control-voltage, especially for the first several db of gain-reduction. This means less critical tube-balance requirements for a given degree of audible "thump."

In the practical-operating case where adequately well-matched tubes are used, the CBS 1-A amplifier is effectively "thump"-free. The

(*Continued on page* 128)

Design of Recording Studios for Speech and Music

By GEORGE M. NIXON, Engineering Staff NBC
and JOHN VOLKMANN, RCA-Victor Division
Radio City, New York

Adjusting reverberation time-frequency characteristics to fit requirements for broadcast transcriptions and home records

• The new recording studio, Studio 3A, to be used jointly by the NBC radio recording division and RCA Victor is designed both for transcription and "home" records. The studio has a volume of approximately 68,000 cu. ft., a length of 80 ft., a width of 50 ft., and a height of 17 ft. It physically replaces the former broadcast studio 3A designed in 1933 when NBC first entered Radio City.

The acoustical problems involved the accommodation of any type of program to be recorded which might be performed by 1 to 50 performers and to provide as nearly as possible ideal acoustical conditions for these performances. The experience gained in broadcasting over a period of years indicated the ideals to be achieved for the transcription type of recording as a transcription is a broadcast which is "delayed" in transmission to the listener. The many years of experience in recording for "home" records was also of help in establishing acoustical requirements for record purposes. Two views of the studio are shown: one of the studio over all (Fig. 1) and one of the platform end of the studio (Fig. 2).

STUDIO design is almost entirely empirical. This fact contrasts sharply with experience in other technical phases of telecommunications. For this reason no analysis of the problem of finding the best studio design together with the rigorous engineering solution have been incorporated in this article. In the construction of this chamber, however, the authors drew on their ample experience. That this method was correct is proved by the excellent results obtained. — The Editors.

Fig. 1—General view of NBC studio designed for home records and transcriptions

The acoustical criteria for a studio designed for transcriptions and one designed for "home" records are somewhat different, largely as to the frequency-reverberation time characteristics. Transcriptions are designed to simulate broadcasts and for that reason acoustical conditions should be substantially the same as those used in broadcast studios.

Acoustical Problems

A single broadcast program practically always involves an appreciable percentage of speech—either announcements, talks or dramatic presentations — which require a somewhat non-reverberant acoustical condition to prevent an excessive amount of reflective sound from reaching the microphone and creating an impression of room size. On the other hand, the studio also must be fairly reverberant for the proper tonal quality of music or other program material. In the broadcast studio these two requirements must be coordinated rather than compromised with resultant unfavorable effects for both conditions.

The recording studio is concerned almost exclusively with music and for that reason the problem is the provision of the proper reverberation characteristic for the type and size of performing group. When speech is recorded, control may be exercised by the use of sound ab-

Fig. 2—View of the platform end of the studio showing curved splays at back

sorbent "flats" as there is no problem of providing for a "visible audience", to see the performers as in the case of many broadcast studios.

Studio 3A was designed to have *adjustable* acoustics so that the acoustical condition could be altered to match the program. A consideration of several methods indicated the most practical solution was the use of heavy lined and interlined draperies "hung 100% full" suspended about one foot from the wall and the use of "hinged" acoustical panels (Fig. 3). The range of adjustment was almost two to one, that is, at 1000 cycles, a change from 0.9 seconds to about 1.7 seconds. The use of heavy draperies hung some distance from the wall insured that the change would be effective even at the lower frequencies (Fig. 4).

Reverberation Time

The shape of the reverberation-time-frequency characteristic curve selected as a design objective is that used by NBC and RCA in studio design in which the reverberation time increases at frequencies below 500 cycles as the frequency is lowered (Fig. 5). Experience has shown that this curve insures a proper tonal balance for both speech and music.

It was desired further that the reverberation time curve extend to as high a frequency as possible before drooping, to insure the highest possible fidelity of recording. A well-known fact is that the absorption of the air prevents appreciable control above 8,000 cycles and with an increase in the frequency it becomes an increasingly greater factor than the absorption provided on the walls and ceiling.

The selection of the reverberation-time-characteristic determines the total amount of absorbing material required but does not indicate its distribution. The distribution of acoustical treatment in a relatively uniform manner combined with the use of diffusely reflective surfaces produces a more diffuse sound field than is obtained in rooms with plane boundary surfaces with concentrated areas of acoustical treatment.

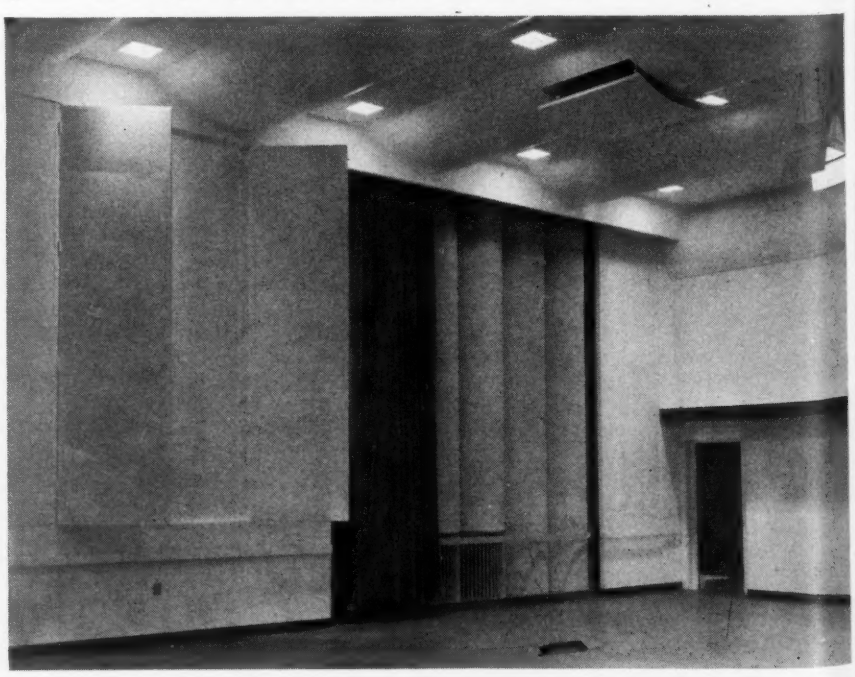
The floor is concrete covered with battleship linoleum and is highly reflective to sound. At the platform end, there are a series of steps, concave in plan, to permit arrangement of the performing group for usual microphone technics. These steps are augmented by wooden platforms as required for individuals or groups of performers in an orchestral or choral performance.

The ceiling above the platform, a distance of 25 ft. from the rear wall, is treated with a series of highly reflective curved plaster quasi-elliptical shapes to reflect the sound diffusely and to deflect it generally outward into the studio. The remainder of the ceiling is treated with large semi-cylindrical plaster shapes extending the full width of the studio interspersed with 3 ft. strips of 1 in. rock wool blanket covered with perforated transite.

The rear wall at the platform end consists of a number of vertical semi-cylinders of different diameters. These may be covered by a heavy drapery so that the wall is changed from a highly diffusely reflective surface to a highly absorbent one.

The side walls at the platform end diverge outward from the rear wall with a series of large vertical convexly-curved plaster shapes

Fig. 3—Note heavy draperies and hinged "acoustical" panels for response changes



which tend to reflect the sound diffusely outward. The remainder of the side walls in general are of curved plaster arranged to be covered by draperies. These draperies are arranged to fit into pockets formed by the curved sections of the wall itself or behind the flat pilasters on which are mounted the hinged acoustical panels.

The emphasis in the design has been toward obtaining a very diffuse sound field. Where this condition is realized, the importance of reverberation time is lessened. That is, in a plane rectangular room experience has shown relatively narrow limits of tolerance from an optimum reverberation time. Where the sound field is more diffuse, the upper limit of this tolerance may be raised appreciably with beneficial rather than objectionable effects.

Diffusing Surfaces

The use of diffusing surfaces with interposed absorbing surfaces results in a very substantial increase in their absorbing efficiency which cannot be neglected in calculations. This is not believed to be solely due to "fringe" or diffraction effects, but rather to the better coupling of the absorbent medium to the air.

The selection of curved plaster surfaces as against wood was simplified in this case because of the desire and the necessity of not using critical materials. Experience thus far indicates that the diffusion is the major factor and its manner of achievement of lesser importance.

Attention is called to the uniformity of the change in the reverberation-time-frequency characteristic (Fig. 4) between the most reverberant and the least reverberant condition. The major acoustical adjustment is by means of draperies which are usually considered to be deficient in absorption at the lower frequencies (below several hundred cycles). The draperies used were quite "heavy", lined and interlined, being about 100% full and about one foot from a diffusely reflective wall. This procedure tends to insure a more uniform absorption characteristic with the use of draperies than the characteristic absorption curve in which the absorption increases with frequency up to one or two thousand cycles and then tends to become less.

The measured reverberation-time-frequency characteristic is shown in Fig. 4, together with the "optimum" curve for broadcasting. It will be noted that in the most reverberant condition, the curve is considerably above the optimum. Further, as the draperies and hinged absorbent panels are exposed, the curve tends to be reduced to the same general extent at all frequencies, thereby maintaining a proper balance between low, medium and high frequencies almost irrespective of the reverberation condition selected.

The characteristic comment of persons hearing performing groups in this studio is that the group sounds larger than it actually is and the tonal quality seems "fuller", "nicely rounded" and similar comments which are difficult to translate into objective technical terms. The exact location of the microphone is found to be less critical and for this reason the producer spends less time in getting the best possible "balance".

The wide range of adjustment of reverberation time will permit verification of the belief, within limits, that the use of as much diffusion as possible is of greater importance than is reverberation time. It requires appreciable time for such studies as only the experience gained under operating conditions with a wide variety of types of programs will permit establishment of refinement of new or existing criteria of studio design.

Acknowledgment is made of the contributions of George Graham and Herman M. Gurin of the NBC Development Group, A. Pulley of RCA Recording and S. A. Caldwell of the RCA Victor Division in calculations, measurements and suggestions.

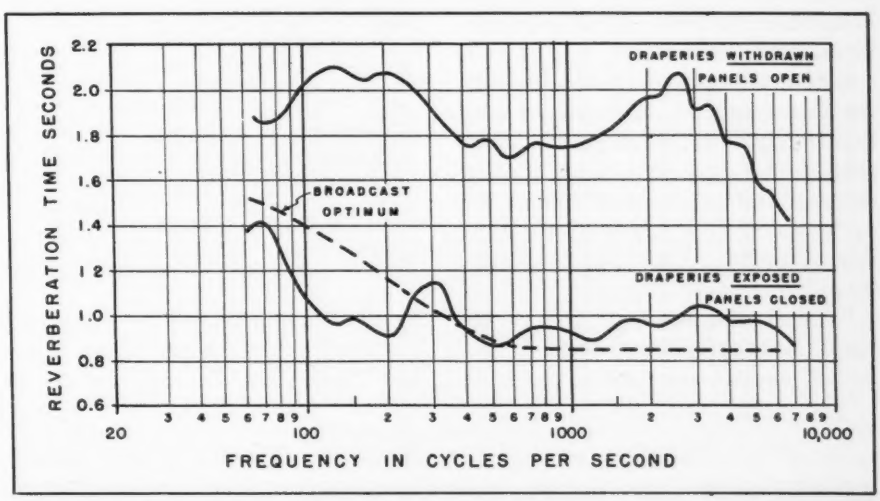
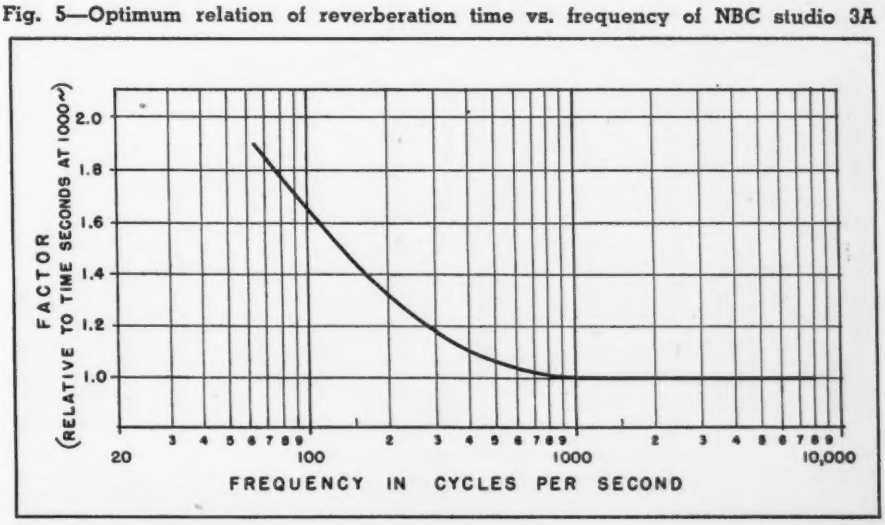


Fig. 4—Reverberation time-frequency characteristics (smoothed average) of studio

Fig. 5—Optimum relation of reverberation time vs. frequency of NBC studio 3A



PICAO Recommends CAA Instrument Landing

By H. GREGORY SHEA
Associate Editor, Tele-Tech

Montreal meeting of Provisional International Civil Aviation Organization (PICAO) results in wide range of agreements on systems

UNDOUBTEDLY one of the most far reaching series of decisions affecting the future of electronics and aviation was completed in November 1946 when the delegates to the Radio Technical Division of PICAO successfully wound up their conference in Montreal. While the complete results have not been publicly announced, TELE-TECH *is bringing its readers here the unofficial decisions of various committees. In general these have been adopted.*

• The method of operation was to appoint committees to consider first the general aspects of the problem of air navigation. Building upon the results of these first committees, other committees evaluated the technical points of various systems available or proposed. Final committees then made the decision as to which systems should be adopted.

Committee H which was set up for the appraisal of *approach and landing systems,* after pointing out that no systems have been devised which meet all requirements set up by committee A, the operational requirements committee, recommended that:

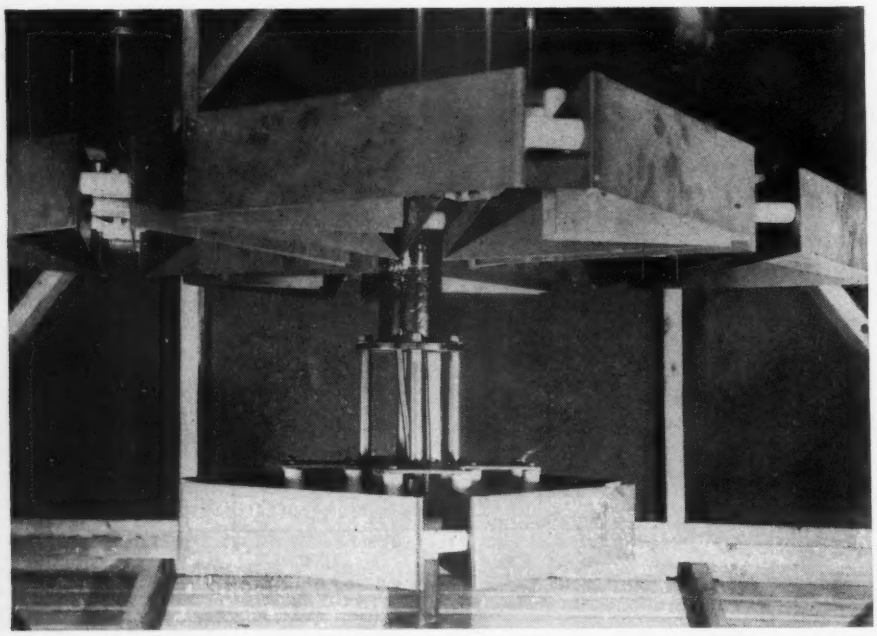
"The equisignal type of instrument landing systems shall be installed on all aerodromes used by international airlines at the earliest possible date and in any event not later than January 1951". It further decided that the phase comparison type of system may be substituted anytime after January 1951; that the equisignal type shall be kept in operation until January 1, 1955, after which it shall be discontinued; that installation shall include three 75 mc markers to be kept in operation until January 1, 1952; that distance measuring equipment shall be added not later than Jan. 1, 1952; that adequate runway and approach lighting must be installed and that where possible two low power medium frequency beacons should be provided at the outer and middle VHF marker sites.

The committee specified that these beacons should have different keying characteristics, that their carrier frequency should not be interrupted and their modulation should be keyed to transmit continuous groups of letters, two at the outer and one at the inner beacon.

Finally the committee recommended that ground controlled approach (GCA), be used where warranted as an aid supplementary to the standard approach system. The committee also noted that development of a microwave landing system might provide a complete scheme fulfilling all of the requirements set up by the operational requirements committee.

As to aerodrome surveillance, the committee recommended that primary radar surveillance should operate in the 10 cm band for the immediate future; that further development of secondary radar (interrogator-responsor systems) be required to provide improved rec-

Civil Aeronautics Administration VHF 5-loop Omni-range antenna



ognition, automatic height reporting and ground selection of height layers for analysis of traffic movement. This development is considered necessary before compulsory installation of responders can be considered. Stated briefly, this all means that the American SCR 51 ILS system has been adopted and further development of the Sperry microwave system and of various two-signal (interrogator-responsor) systems such as General Railway Signal, LANAC, the Panoramic Vertical separation indicator and others be continued.

Low Frequency Loran

Committee F on *Long Distance Aids to Navigation* recommended the adoption of low frequency Loran for installation in the following areas in the order and at the times named:

a—North Atlantic, before January 1, 1949.

b—South-east Asia and Australasia, before January 1951.

c—Africa, before January 1951.

d—Pacific, before January 1951.

e—South Atlantic, before January 1951.

and recommended that standing committees be created to find the proper sites for these installations.

Inasmuch as low frequency Loran up to now has been a secret development of the armed services, revealed for the first time at the PICAO conference, it may be stated here that it is a modification of standard Loran which utilizes a band 20 kc wide at 180 kc carrier frequency and whose sending stations are set up in triplets, one master and two slaves. This gives instantaneous intersecting fixes from one installation. Standard Loran airborne installations can be used to receive L.F. Loran with the help of a simple adapter.

The committee also recommended the retention of existing standard Loran installations and the use of existing airborne sets equipped to receive either standard or L.F. Loran. Further development of the current U. S. program for testing low frequency omni-directional ranges was suggested with the thought that possibly in the future, the decision to try L.F. Loran might be modified. In fact it was stated that the time for complete standardization had not arrived and consequently other systems such as Decca would also be considered in the future.

This same committee was charged with exploring the possibility of adopting a standard altimeter. It decided this was not necessary and noted in its report that the one now available, SCR 718C does not meet the requirements set up by Committee A.

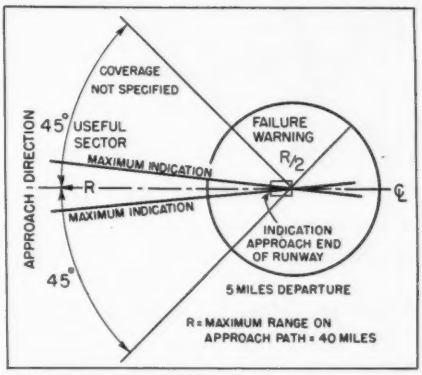


Fig. 2—Landing system warning area

Committee I set up to determine the best *short range aids to navigation* reported itself unable to make a recommendation, the central problem apparently being whether to adopt GEE, the British pulse system, or the CAA omni-range proposed by the U. S. The question was laid before a plenary session and was discussed at length. Finally a special committee was created to make a decision. Its choice was the CAA very high frequency omni-ranges with distance measuring equipment (DME).

Committee K working on *Aerodrome Zone control* found it necessary to divide consideration of its problem into several parts. In regard to Part 1, the *determination of position,* it recommended that primary radars of sufficient discrimination be developed, particular attention being given to making indications simple and readable. A number of other possible non-radar schemes were rejected as impractical.

On Part 2, *determination of identity,* it could find no satisfactory solution although it considered automatic direction finding, secondary radars and coded corner reflectors mounted on planes.

On Part 3, *instruction and guidance systems,* the committee recommended the retention of radiophone as a standby with the development of a fully automatic system as an objective. It directed attention to the possibilities of buried leader cables. In addition it emphasized the need for coordination

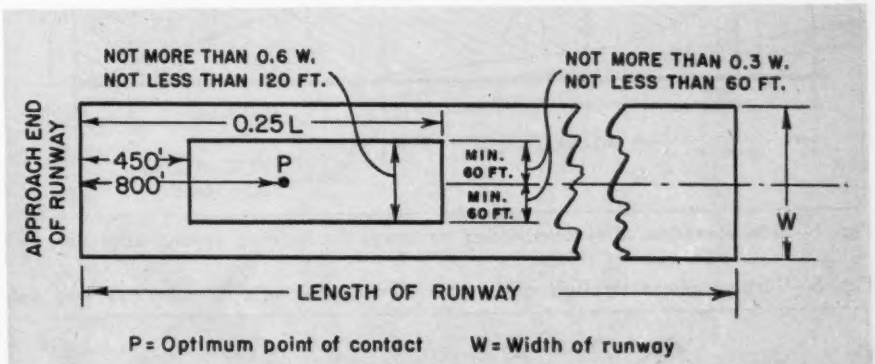
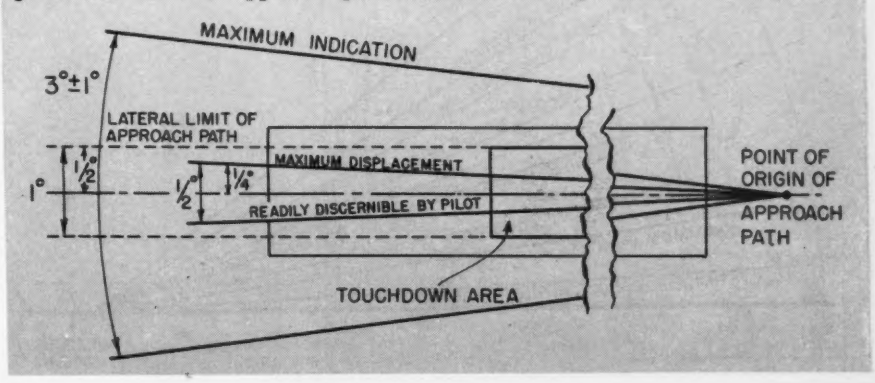
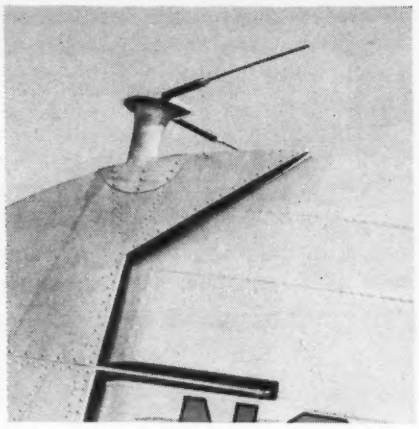


Fig. 1—Final approach and landing system. Touch down area specifications

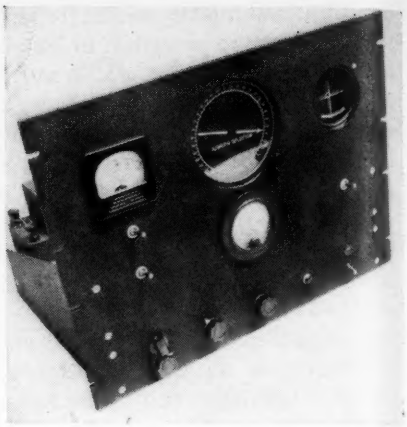
Fig. 3—Plan view of approach path recommended by committee on operations



Omni-range antenna housing, screen



Omni-range coaxial V plane antenna



Omni-range monitor, rack mounting

between radio aids and lighting systems developments.

A committee charged with standardization of *VHF radio telegraph transmission* decided upon ON-OFF keying of 1000 cycle audiotone amplitude modulated on a continuous wave carrier. It also decided to permit special communications using tones other than 1000 cycles for indicator signalling.

The committee N, on *frequency allocations,* made the following assignments:

Short Distance Navigation Systems

VHF Omni-range—112-118 mc.

DME—a band 40 mc wide between 200 and 300 mc (the U. S. considers that a band near 1000 mc would be more satisfactory and does not concur).

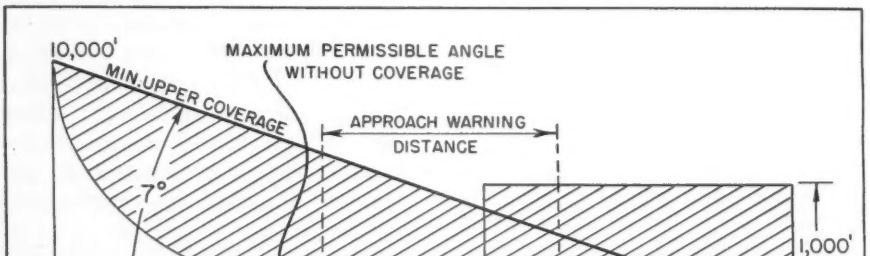
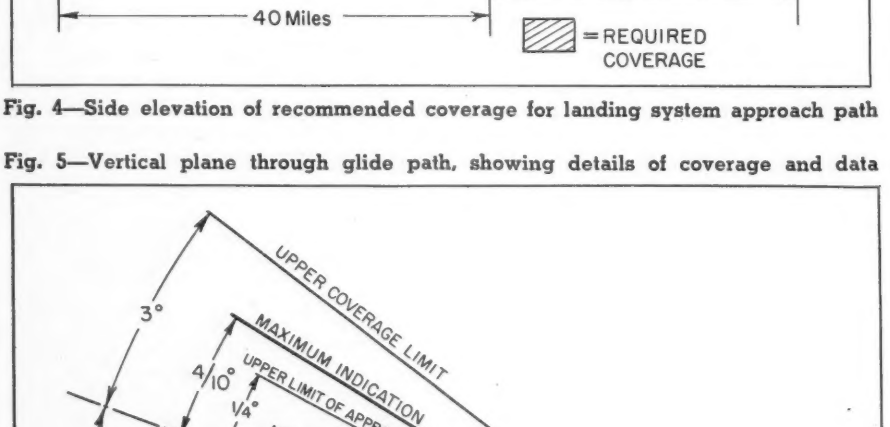


Fig. 4—Side elevation of recommended coverage for landing system approach path

Fig. 5—Vertical plane through glide path, showing details of coverage and data



Instrument Approach and Landing Systems

ILS Localizer (CAA)—108-112 mc.

Glide path—328.6-355.4 mc.

Markers—Centered on 75 mc.

GCA—General search 2700-3300 mc (the band 3246-3266 mc reserved for transponder beacons).

Precision search 8500-10000 mc (the band 9300-9320 mc reserved for transponder beacons).

ILS (Microwave)—3000-5250 mc.

Long Distance Navigational Systems

Standard Loran—1800-2000 kc.

L.F. Loran—A band 20 kc wide near 180 kc.

Surveillance Radar

Primary radar—2700-3300 mc (the band 3246-3266 mc reserved for transponder beacons).

In many respects the work of Committee A on operation requirements, or rather more exactly on *Functional Requirements and Present Needs* represented an outstanding contribution to the art of adapting electronics to air travel. Due to the voluminous nature of its findings, these can not be reproduced here in toto, but some of the most important parts have been extracted and analyzed.

In general it may be said that this body set up rigorous objectives and error limits to be striven for. In many cases these are not yet capable of fulfillment.

In setting requirements for radio navigation, Committee A decided that the system used should be such that "it is possible for the aircraft to be navigated over all portions of the route . . . including

take-off and landing, without visual reference to the ground, under all flying conditions and without assistance from the ground control".

We may digress a little here to point out that this is based strictly on the philosophy that the pilot is king in the air. It makes no concession to the possibility of automatic control of planes without the pilot's volition in a congested approach and landing area such as is envisioned by some advanced thinkers in this field.

Approach and Landing Aids

In establishing the needs for final approach and landing, this committee specified that the aids should permit an actual landing or alighting on water and that adequate static-free communication, as well as lighting, should be provided and that identification of runways or channels should be possible. Precise distance indication also was set up as a requirement and a means for providing immediate and positive indication of malfunction. Either automatic or manual flight was specified. In addition a scheme on the ground which would automatically and radically change the character of its indication in case of divergence from proper alignment is needed, said the committee. They also recommended that the system should not be a limiting factor on the traffic capacity of an airport and should provide reduced service to aircraft with limited equipment.

The committee also set up standards for ideal short distance aids to air navigation and to air traffic control. In the case of the latter, the requirements include: visual presentation of instructions and information, completely automatic traffic control, automatic recording, freedom from language difficulties, continuous presentation of the traffic pattern including plan position, altitude and identity of aircraft, collision warning, failure indication and hazardous weather indications —truly a formidable set of requirements! The committee stated that no suitable equipment was now in existence.

In the case of short distance aids, requirements relate to accuracy and to possibility of integration into complete navigation systems.

In the approach zone, wrote the committee, the air traffic control system must provide surveillance, selection and guidance of landing

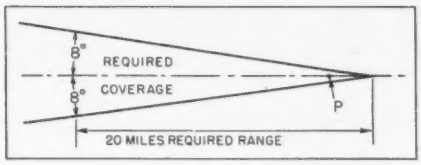


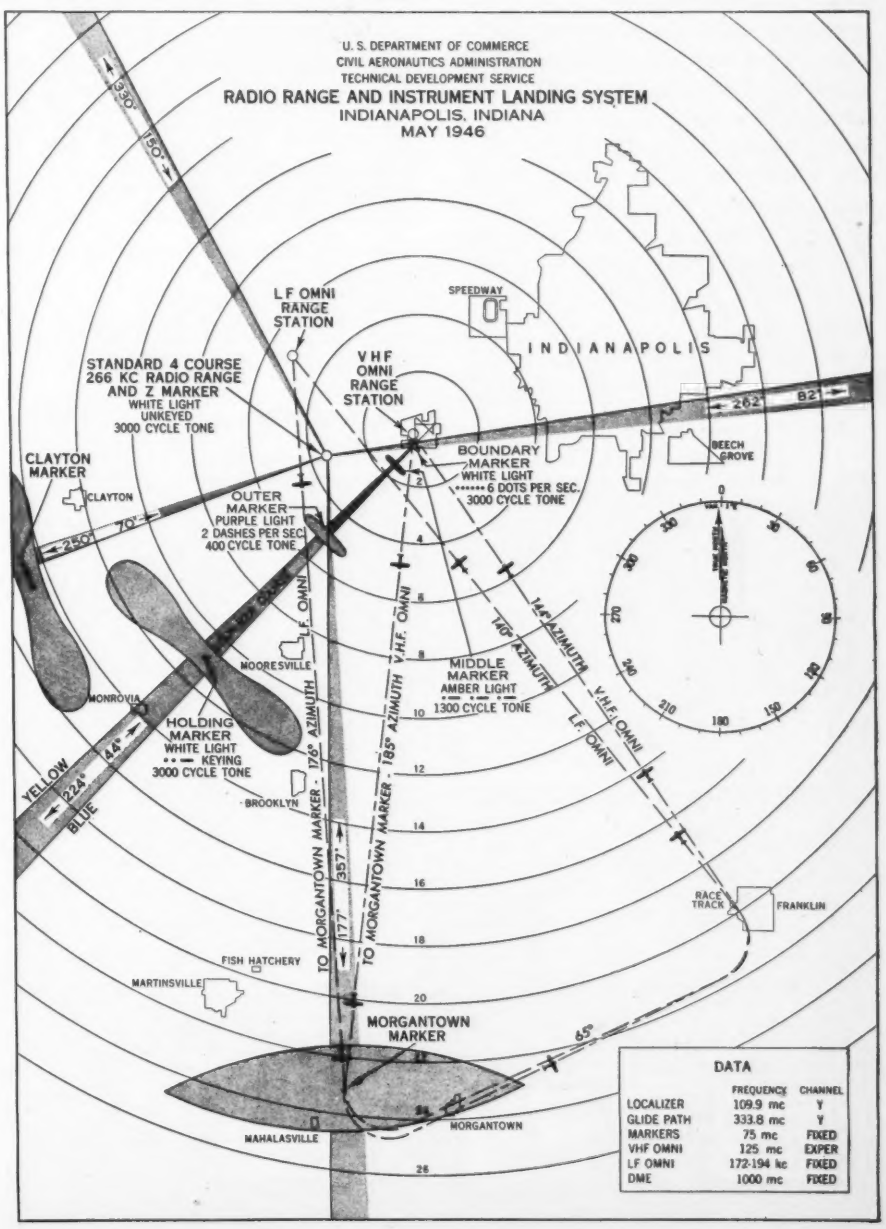
Fig. 6—Glide path plan coverage

planes, holding, accurate monitoring and control. It must be usable in all weather visibility and surface conditions.

Minimum requirements for approach control include—(1) a 360° coverage out to 25 miles; (2) a height coverage to 8000 ft. for small and 10,000 ft. for large aircraft; (3) a height finding scheme accurate to 1000 feet within 2° and with a relative accuracy on airplanes within 25 miles of 500 feet; (4) slant ranges accurate to ¼ mile within 25 miles and resolution of aircraft within ¼ mile of each other; (5) azimuth determination within 1° and resolution of two planes within 2° of each other; (6) position of all aircraft clearly shown and other information available at controller's discretion; (7) a plan position indicator; (8) a bearing indicator; (9) for specially equipped aircraft, an identification provided automatically; (10) for specially equipped aircraft, height

(*Continued on page* 124)

Complete installations of various ranges and landing systems at CAA Indianapolis



Television Synchronizing Signal Generating Units

By RALPH R. BATCHER
Consulting Editor, Tele-Tech

Part 2—Reviewing methods and equipment needs for combining picture and sync. signals, using monoscope or image cameras

● The equipment described in Part I* provided only the control signal pulses that occur during the return sweep intervals of the scanning period. For the other 90% of the time occupied by each scanning line a monoscope camera provides an easy means of synthesizing a pattern for use in the analysis of individual items of television equipment or in the operation of an overall television system. Thus, when such a camera is used in conjunction with the synchronizing generator and distribution amplifier, a complete setup is available for the bench testing of video amplifiers. The addition of an IF sweep generator and rf signal generator will provide all facilities essential to the testing of complete receivers, as in Fig. 1.

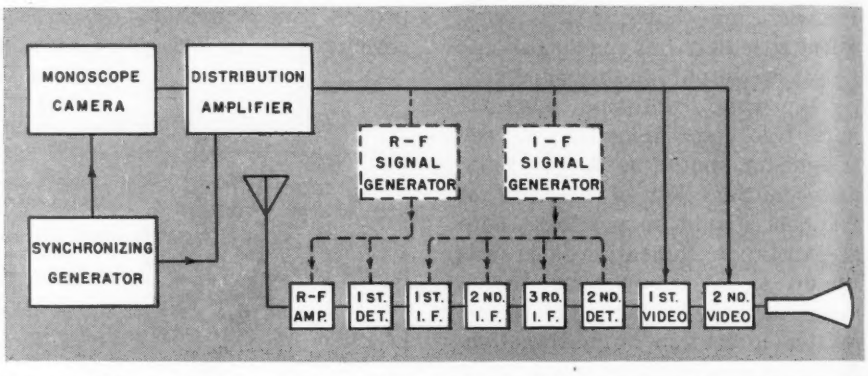


Fig. 1—RCA equipment set up provides all the facilities for complete receiver testing

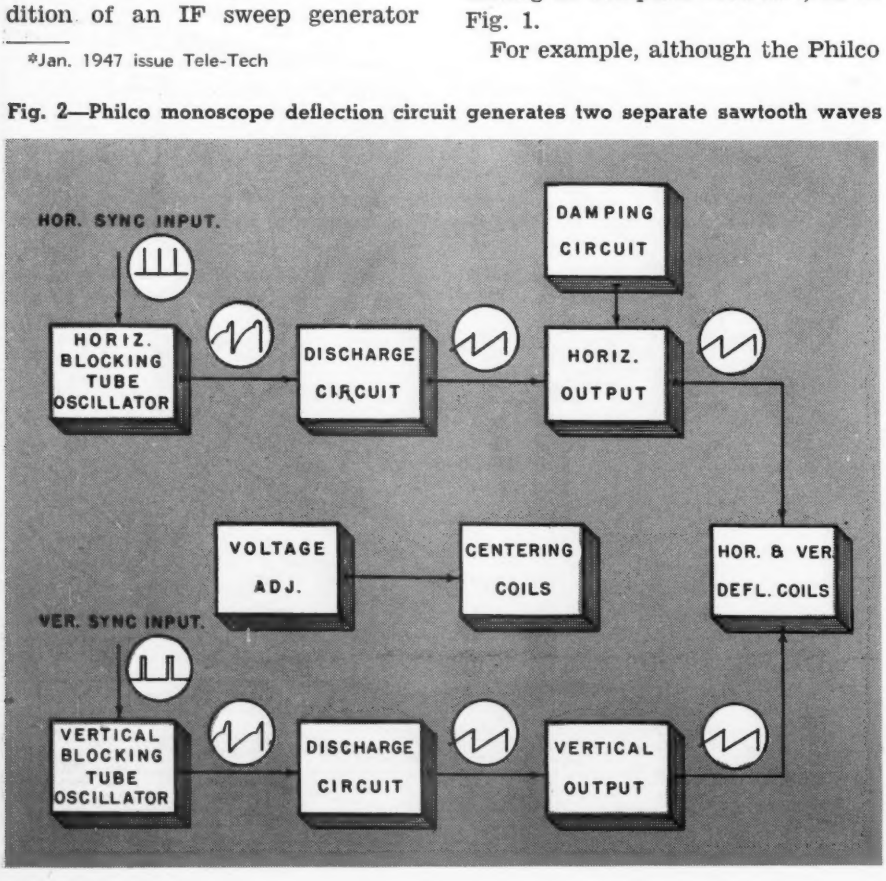
For example, although the Philco television engineering group† was primarily interested in equipment that could be used in the laboratory and on production lines, their test unit was designed to be used just as well as television control room equipment. Further, this unit was so constructed that it could be used in conjunction with regular studio cameras and their associated equipment since it was decided to limit its use to the supplying of a test pattern. Thus, an interim studio can readily be obtained for those desiring to enter the television broadcasting field at minimum cost.

This test pattern generator unit utilizes a monoscope tube wherein the pattern to be generated is printed on an aluminum plate with carbonized ink. Since the aluminum surface has approximately five to ten times as much secondary emission as the carbon, a television signal can be generated by scanning the printed aluminum plate. In this manner the printed pattern provides an "electrical" picture with sharply cut details. To operate this

*Jan. 1947 issue Tele-Tech

†From data submitted by David J. Miller, Jr., Philco

Fig. 2—Philco monoscope deflection circuit generates two separate sawtooth waves



tube a monoscope deflection circuit is provided as in Fig. 2.

This unit generates a saw-tooth current wave at horizontal and vertical frequencies, and also provides a variable voltage to the horizontal and vertical centering coils at the signal generator tube, thus making it possible to center the deflected field on the signal plate. Here horizontal and vertical synchronizing voltages are fed into the deflection unit from the synchronizing distribution unit. The former triggers a horizontal blocking oscillater feeding into a discharge circuit generating a saw-tooth of voltage, which is imposed on the grid of the horizontal output tube. This causes a high voltage pulse to be generated in the plate circuit of this tube due to the inductance in this plate circuit. In order to prevent transient oscillation, a damping tube is used which will conduct on the negative return of the pulse.

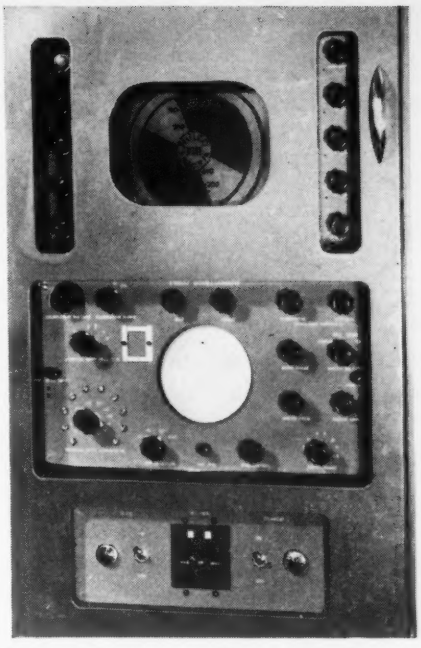
Horizontal Deflection Scheme

The saw-tooth of current generated in the horizontal output tube is now fed to the horizontal deflection coil through a coupling transformer, thus causing the horizontal deflection in the signal tube.

Vertical synchronizing pulses fed into the vertical deflection circuit cause a blocking oscillator and a discharge circuit to work in a similar manner. However, working now at 60 cycles, there are no large amplitude pulses formed by the inductance in the plate circuit of the vertical output tube. Instead the inductances behave as nearly resistive components, and the small pulse is damped with a shunt resistor across the primary of the vertical output transformer. The saw-tooth generated is fed to the vertical deflection coil, resulting in a saw-tooth of current in this coil and therefore a vertical deflection in the signal generator tube.

Due to dissimilarity of various signal generator tubes it is necessary to provide a centering device for the image field in the tube. Therefore coils which will effect centering are provided, together with a variable voltage to change the fields around these centering coils.

The Philco television signal generator is housed in three conventional steel cabinets. In the first of these the synchronizing timing and shaping units, and the synchronizing distribution unit, are located together with their associated power supplies. In the second, the monoscope tube and the associated video amplifiers, a deflection unit, an anode supply and the necessary low voltage power supplies are found. In the last rack are a linearity check generator, a picture monitor, a test oscilloscope for checking operation of the entire assembly, an ac control panel and, as in the other two racks, power supplies for the contained units. The diagram (Fig. 3) shows signal connections for the complete system.

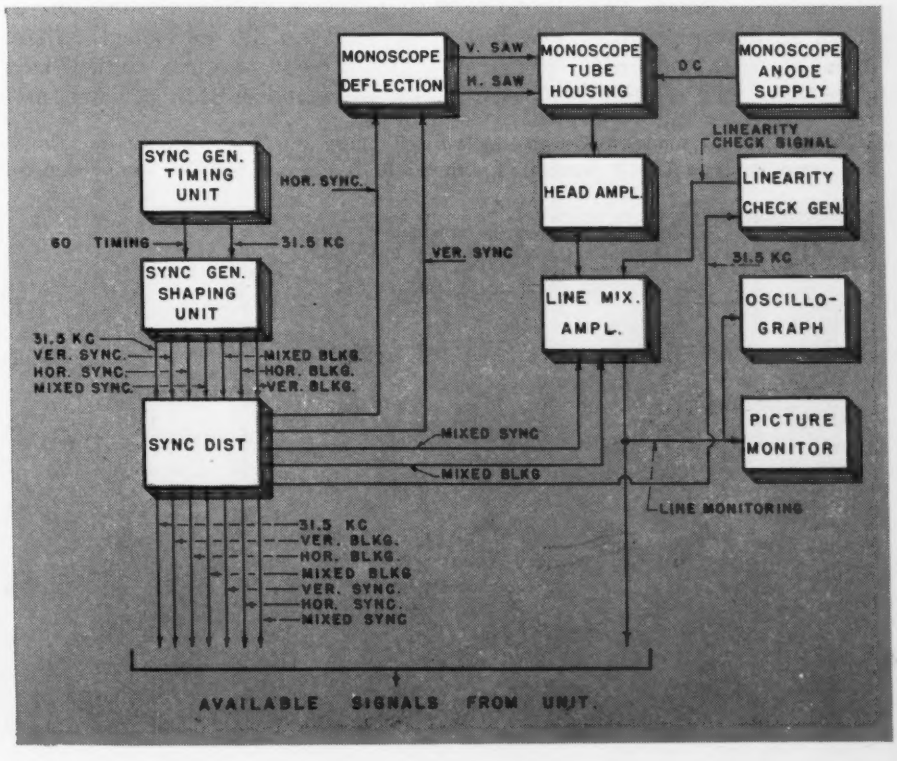


Monitoring tube (top) and Oscillograph unit in monoscope signal generator (Philco)

Another feature included in the synchronizing generator timing unit is a circuit which makes it possible to observe on the monitoring oscilloscope any portion of one line of horizontal sweep in a picture, and to observe the sychronizing signals in detail. From the fourth counter, the three-step output is fed to a clipper which will select the leading edge of the third (top) step, differentiating and clipping so that the resultant pulse can be used to trigger a delay multivibrator circuit. The useful portion of the pulse from the delay multivibrator is the trailing edge; so, by differentiating the square wave and then inverting, a pulse is obtained which can be used to fire a sweep multivibrator.

The width of the pulse from the delay multivibrator may be changed by varying the bias so that the differentiated trailing edge occurs between 500 and 5000 microseconds after the pulse which fires this multivibrator. This sweep multi-

Fig. 3—Interconnections to the various elements of the Philco signal source



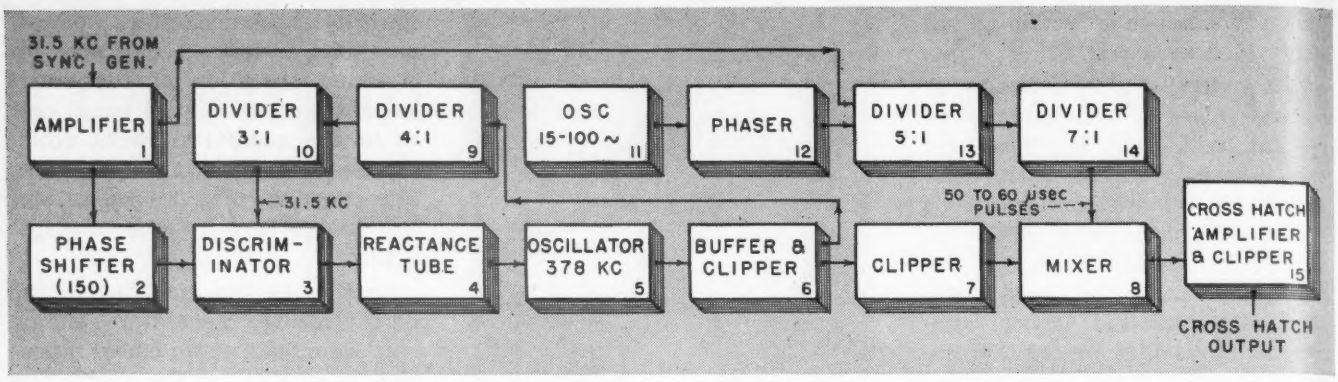


Fig. 4—Linearity check generator which can be used in connection with a "ball chart" to test for linearity at any point in system

vibrator in turn controls a discharge circuit which varies the length of a sweep of short duration between 1 and 30 lines. This sweep is fed to the horizontal deflection circuit of the monoline oscilloscope.

On this test scope, the sweep occurs once during each 60-cycle period, and can be so adjusted in phase that it is possible to observe any portion of the 60-cycle interval such as near the vertical synchronizing signal 10 horizontal lines, thus displaying any desired portion of the mixed synchronizing signal.

Linearity Check Generator

Another unusually valuable panel on the Philco setup contains the linearity check generator used in conjunction with a "ball chart" pattern of accurate geometrical design projected on the mosaic of the iconoscope. Since the linearity check generator produces a perfect linear electrical pattern of the same dimensions, the mixing of its electrical signal with that of the ball chart produces two coincident superimposed patterns as seen on a monitor tube. Therefore this device can be used to test for linearity at any point in a television system, since non-linearity results in non-coincident patterns. The size and linearity of both the monitor oscilloscope and the monoscope deflection circuits can then be adjusted to give a linear reproduced test pattern.

As shown in Fig. 4, a negative resistance oscillator operating at 387 kc, is frequency-controlled by division (with a pair of counters) to approximately 31.5 kc, and comparing the output with the 31.5 kc pulse signals obtained from the sync generator, both being fed to the reactance tube grid to maintain the 387 kc oscillator frequency.

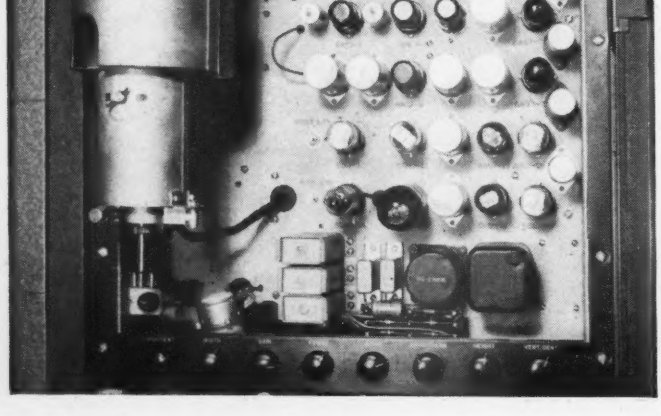
This 387 kc sine wave is clipped and amplified in six stages so that a pulse as narrow as 0.15 microsecond can be developed. There should be 19 of these vertical bars on a standard RMA 525-line picture, the other 5 being eliminated by horizontal blanking.

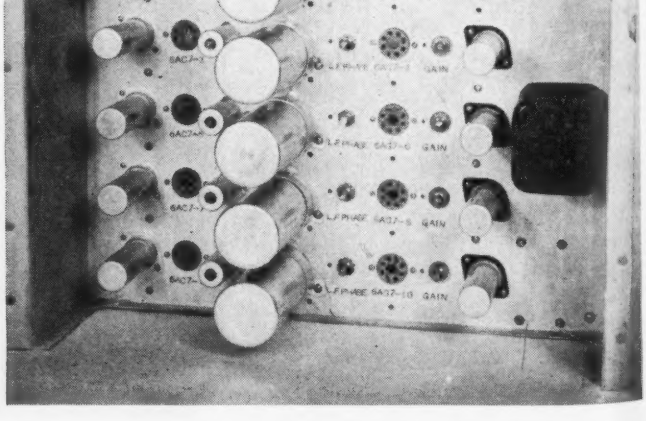
The 31.5 kc from the synchronizing generator, divided down to 900 cycles by a pair of counters, synchronizes a multivibrator which generates another pulse approximately 60-120 microseconds wide, equal to one or two horizontal lines. There should be 13 of these horizontal bars visible, the other two being eliminated by vertical blanking. The 387-kc and 900-cycle pulses are mixed and further clipped and with a cathode follower developed across a 70-ohm line, applied to the line mixing video amplifier.

Monoscope System

A monoscope camera supplied with the RCA equipment uses the type 2F21 monoscope tube with a suitable test pattern printed on the signal plate. A video signal of known quality and design is therefore constantly available as a substitution for a standard studio camera. The monoscope camera has an

RCA type TK-1A monoscope camera, left, with tube shield swung out for tube replacement. At right, front view of distribution amplifier type TA-1A associated with the RCA system. Gain adjustments provide equalized signal levels to outgoing lines





output voltage of 1.5 volts peak-to-peak. Vertical and horizontal deflection amplifiers, a video amplifier, plus low and high voltage sources make up the complete camera shown in the block diagram of Fig. 5 and the photograph.

The vertical driving pulse, received from an external source such as the synchronizing generator, is fed directly to the vertical deflection generator of the monoscope camera. This is a four-tube circuit which consecutively amplifies the received pulse, generates a sawtooth wave, drives the magnetic deflecting coils of the 2F21 monoscope tube, and provides negative feedback for improved scanning linearity.

Blanking Amplifier

The external horizontal driving signal is fed to the three-tube horizontal deflection amplifier where it is shaped, amplified and fed to the horizontal deflecting coils.

To provide the correct polarity and proper level, blanking signals received from the external synchronizing generator are fed first to the blanking amplifier. This output is then fed to the video amplifier where the blanking pulses are mixed with the video signal.

The output signal from the monoscope tube is fed directly to the first stage of a six-stage video amplifier. The blanking signal enters at the output of the fourth stage. The fifth stage output is by-passed to a clipper tube which provides the correct, uniform height to the blanking pedestal prior to entering the output stage. The two tubes comprising the final stage operate with their grids in parallel but with individual plate circuits which provide two separate outputs.

In laboratories and factories, where video signals must be delivered to a number of test positions a high degree of isolation must be achieved so that any disturbances set up by one piece of apparatus under test is not reflected to others. Two connection jacks are provided at both the input and output to facilitate interconnecting sections. The amplifiers may be used to connect up to five cameras or studios to a single line, or may be used to redistribute a single program signal to several output positions.

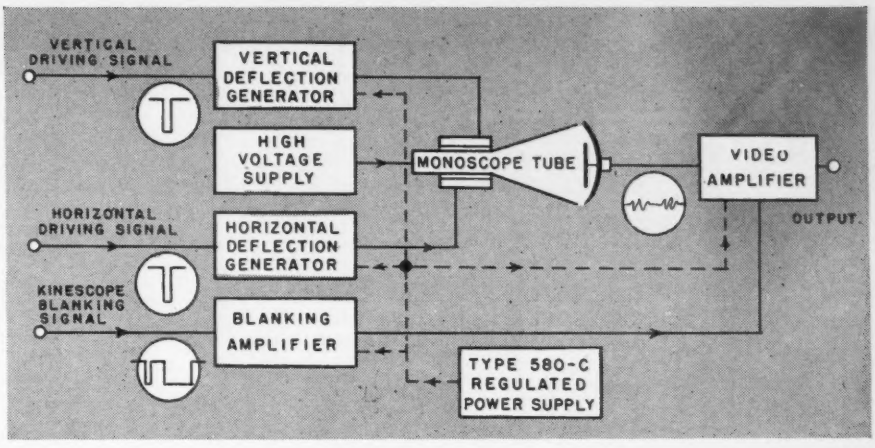


Fig. 5—Elements of complete RCA camera showing signal paths and wave forms

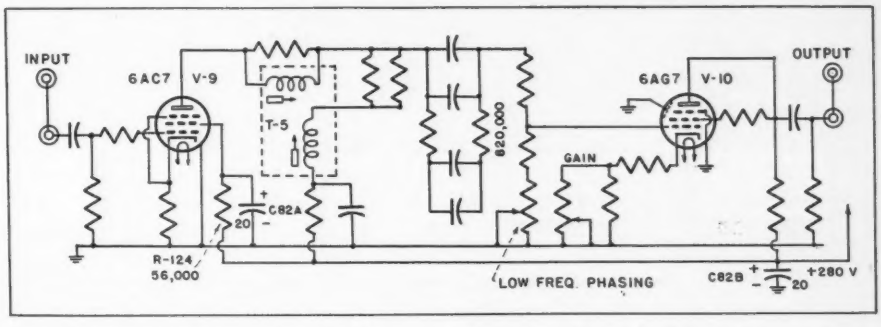
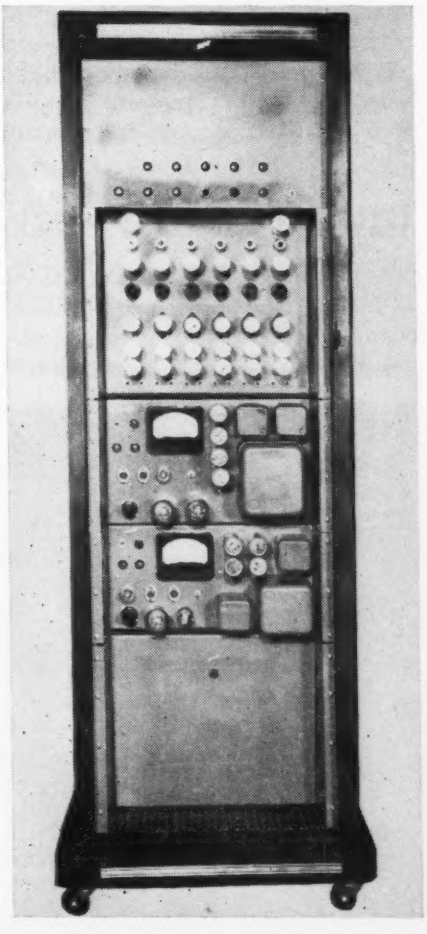


Fig. 5—Elements of complete RCA camera showing signal paths and wave forms

Television signal distribution amplifier manufactured by Telequip Radio Co. (Chicago) for studio or production setups



Because of the unusual requirements brought about by transmitting a band of frequencies from a few cycles to 4.5 mc wide to various points in the setup, a special distribution amplifier is necessary to give greatest flexibility.

Signal Distribution

In the RCA system each distribution amplifier consists of five individual, two-stage video amplifiers, each having an extremely high input impedance so that all may be bridged across a single source. Although no overall gain is provided, the output may be varied between 0.9 and 1.1 of normal level for accurate equalization of picture levels to several distribution lines. The maximum input or output signal level per section is two volts, peak-to-peak, with either positive or negative polarity. Two controls—a gain control and a low frequency phasing adjustment—are provided in each amplifier (Fig. 6).

In television station installations and in some laboratory and production line distribution systems, a complete monitoring unit adaptable to the supervision of composite picture signals at any stage of

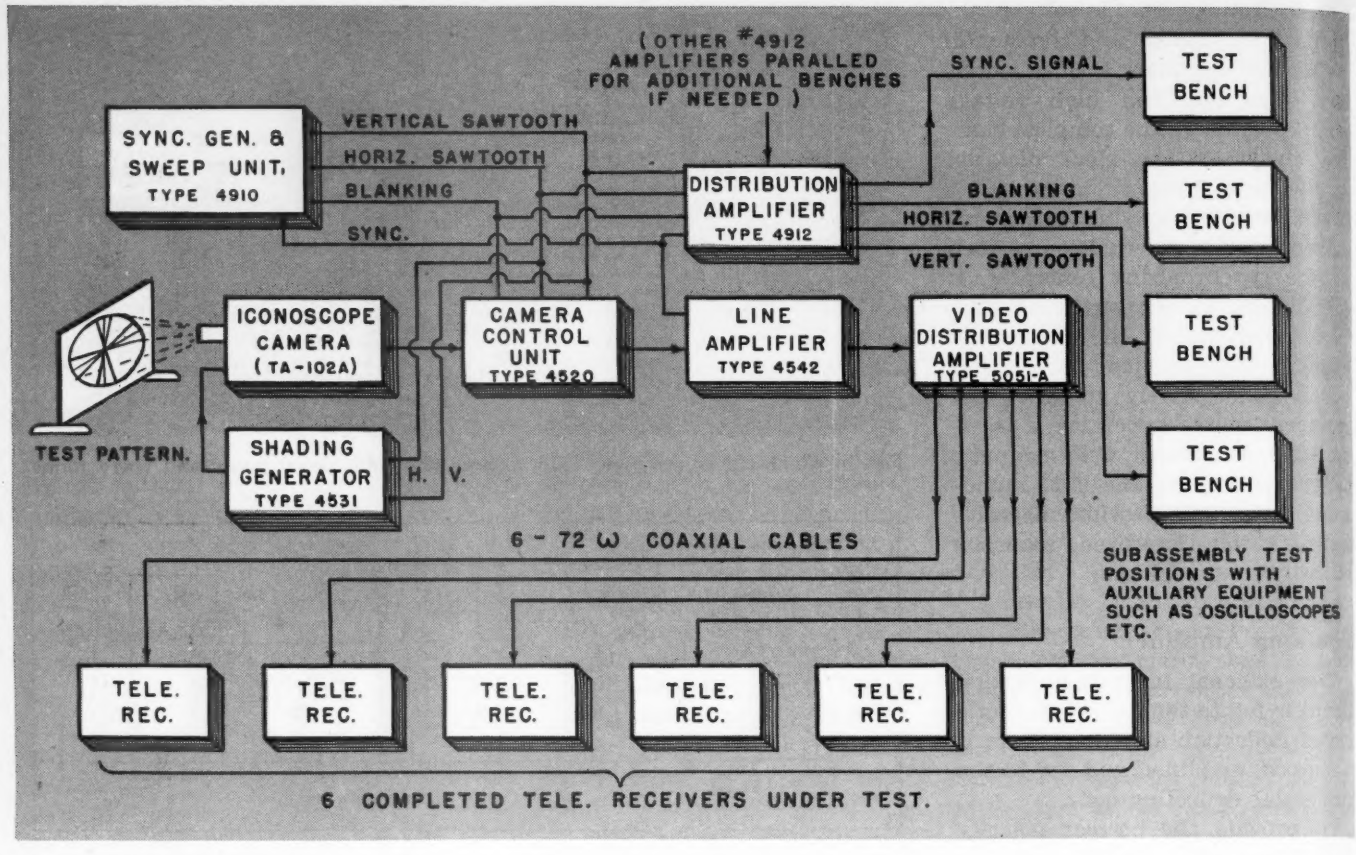


Fig. 7—Equipment supplied by Du Mont for production line receivers being tested. Useful for partial or complete assemblies

transmission, from camera pickup to radio transmitter input is installed. It may be used for both reproducing the picture and delineating the video waveform. To permit its use in several ways it can be either panel mounted or placed in a housing and grouped with the operating console.

The unit employs a 10 in. Kinescope type 1816P4 with an aluminum-backed screen, for direct picture monitoring and a 5 in. oscilloscope for signal component analysis. Input circuits are arranged to permit the same or different picture signals to appear on the kinescope and oscilloscope screens at the same time. A calibration circuit is included to establish a definite voltage level on the oscilloscope screen for measuring purposes.

The frequency response of the circuit is in keeping with television requirements. The kinescope amplifier is flat within ± 1 db up to 6 mc, and the amplifier vertical deflection of the oscilloscope is flat within ± 1 db to 5¼ mc. The input impedance is extremely high on all circuits.

The Du Mont Laboratories have suggested the use of certain items of their regular Iconoscope camera chain to develop a suitable test signal. Fig. 7 itemizes the equipment for one production line setup, which enabled both partial and complete assemblies to be checked. The use of a standard camera and control unit permitted a more flexible selection of test patterns and the possibility of line pickups when desired. Additional distribution amplifiers could be added for extending the service to other benches if necessary.

Infrared for Secret Communications

A new form of communications — infrared beamcasting — makes possible secret two-way conversation in ship-to-shore communications, blackout flying, or in disaster areas where telephone lines are cut; it is unaffected by weather conditions or static. The invisible searchlight beam is produced by a caesium vapor lamp, which is a poor visible illuminant, but a very efficient infrared generator. The ability of the caesium vapor lamp to alternately dim and brighten thousands of times a second, called its modulability, is almost 100% over the audio-frequency range from 200 to 3,000 cycles, thus making it suitable for practically instantaneous transmission of words at normal conversational speed with good telephone quality. The device was originally developed by the Westinghouse Lamp Division, Bloomfield, N. J., for Navy convoy duty and for landing instructions.

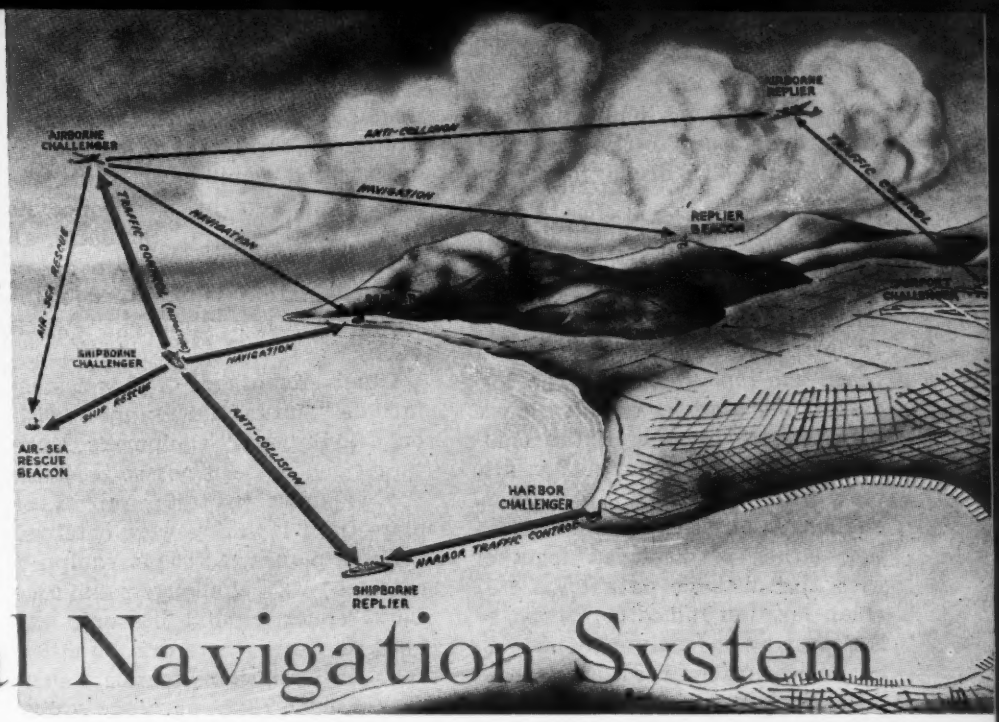


Fig. 1—Types of challengers and repliers used in LANAC air navigation

Keyed signals trigger reply transmitter helping to prevent occurrence of collisions

LANAC Two-Signal Navigation System

• Even radar with its near-miraculous capabilities suffers a crippling handicap in practical navigation, for radar cannot identify the objects it locates. Though radar instantly tells where an object is, oftentimes what it is, radar never tells who it is. As far as radar alone is concerned, the *known* object so essential to any navigational fix does not even exist!

During the war when radar directed the fire of guns, this handicap necessitated the development of special pulse equipments for the rapid identification of friendly targets. Such equipments were used in IFF (Identification, Friend or Foe) systems* and not only provided immediate identification of unknown objects, but furnished the distance and direction data as quickly and surely as radar. IFF equipments, in other words, met all the demands of practical navigation, and consequently were drafted into military navigation long before the war ended.

From IFF to Lanac

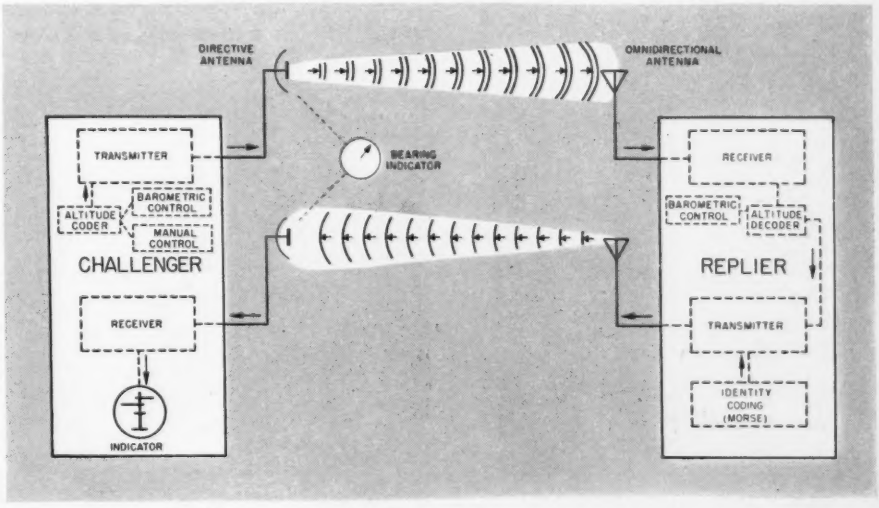
To avoid a postwar repetition of the costly battle-taught lesson that radar alone is not enough, the technics used in IFF have been applied to a new commercial navigation system prepared by the Hazeltine Electronics Corporation. Like IFF, this system, called LANAC (Laminar Navigation and Anti-Collision), provides for rapid identification of all properly equipped craft and beacons, as well as instantaneous display of their distance and direction. LANAC, is also notable for its "laminar" feature (described later) providing altitude identification of planes.

LANAC'S primary advantage, is its sure and rapid means of converting all important unknown objects into known objects. This statement is particularly true in light of the fact that expeditious movement from "here" to "there" is no longer a matter simply requiring a landmark or two to be known. Each individual craft must be identified—"but quick!"—if the dangers and inconveniences attendant upon the increasing congestion of airway, airport, and harbor traffic are ever to be dispelled.

Two basic types of pulse transmitter-receiver equipment, a "challenger" and a "replier", are used. Both operate in the 1000 mc band, and variations of either type are available for aircraft, ship, or ground stations. For simplicity, only one type of LANAC equipment is indicated for each craft in Fig. 1, but actually all craft would be required to carry both.

The challenger (interrogator-responsor) transmits a series of paired-pulse "challenge" signals to the replier (transpondor) at the distant target, where they automatically initiate a series of Morse-coded "reply" signals. These re-

Fig. 2—Elements in aircraft challenger-replier. Two antennas shown for clarity



*See Identification, Friend or Foe—Radar's Sixth Sense. TELE-TECH, January, 1947.

plies, transmitted omni-directionally, then return to the challenger where they are displayed on one or more 'scopes.

The Morse coding identifies the challenged craft or ground station in about 15 seconds, and the target's distance is given by the time required for a challenge signal to reach the replier, and for the corresponding answers to travel back. The relative bearing of the challenged craft or ground station also may be obtained with a directional challenger antenna. This information either is displayed together with the distance data on a PPI (Plan Position Indicator) 'scope, or is shown by the pointer of an antenna bearing indicator.

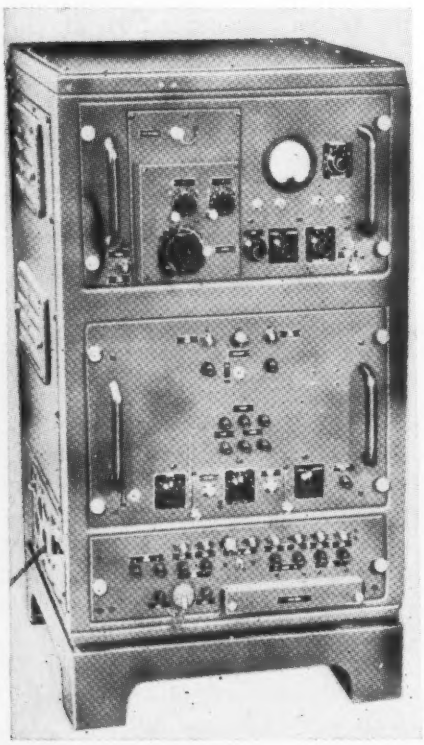
Block diagrams of the basic elements in the aircraft challenger and replier appear in Fig. 2, where separate transmitting and receiving antennas are shown to clarify the picture. In practice, all challengers and repliers have common antennas for transmission and reception, T/R (transmit-receive), or duplexing, circuits being utilized to protect the receivers while the transmitter is operating.

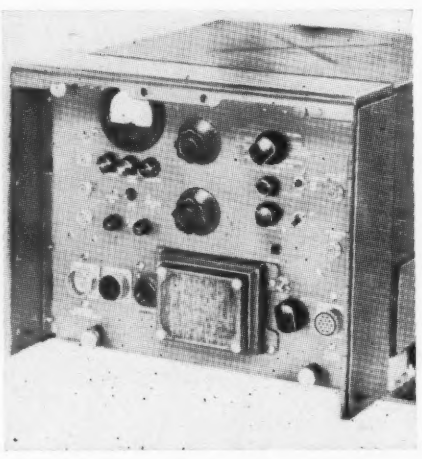
The automatic aspect of LANAC equipments deserves special notice, since it eliminates many annoying duties that are presently imposed on busy pilots, navigators, and radiomen. Thus, all information required *from* an air or surface station is furnished by completely unattended equipment, since the replier answers by itself once its power switch is on. Similarly, all information required *by* an air or surface station is obtained automatically once a "challenge" switch is on.

Other advantages of this system include substantial ranges with only low power equipment since target echoes need not be received. For example in tests, ranges of more than 100 miles were obtained between planes at 5,000 ft. equipped with 1500-watt challengers and 500-watt replier ground beacons. At 1,000 ft., ranges were over 50 miles. For anti-collision service, such ranges mean early warnings equivalent to 5 to 10 minutes of flying time. In contrast, airborne radars give a maximum of ½ to 1 minute of warning when training on other planes.

In addition, since different frequencies are used in challenging and replying, fixed echoes and clutter from foreign objects do not interfere with clear operation as they do in radar. Furthermore since challenge signals are coded and the challenge receiver is gated so as to be insensitive to foreign signals, only pertinent data are received.

The challenge code (which has nothing to do with the Morse reply code) is determined by the number of microseconds elapsing between the first and second pulses of each challenge signal, and any one of 12 or more such pulse-spacing intervals—each corresponding to a different type of required information—may be selected manually or automatically at the challenger. The challenge codes are automatically decoded in the replier receiver by a discriminator (decoder) circuit, which rejects all incoming pulse pairs except those properly coded to demand an answer. In a typical example, a replier whose decoder is set for 3 microsecond spacing will not reply to any other type or combination of signals.





Ground and shipborne challengers. A complete high power model is shown at the left and a medium power below

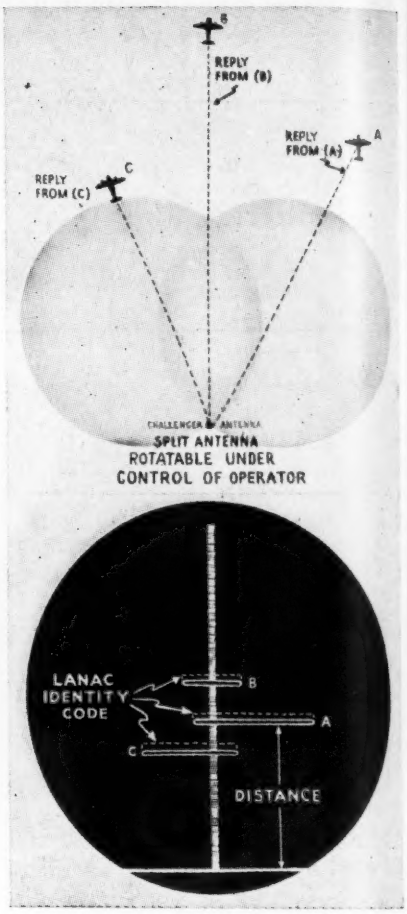


Fig. 3—Anti-collision display for aircraft is an L scope. Length shows direction

The Laminar Method

In accordance with the present system of controlling airway and airport traffic by requiring separate thousand-foot altitude intervals to be maintained between planes*, LANAC electronically divides the air into thousand-foot altitude layers, or "laminas", with a distinct "altitude" (challenge) code for each.

*To help prevent collisions, existing CAA regulations require northbound and eastbound airway traffic to fly at odd thousand-foot altitude levels, and southbound and westbound airway traffic to fly at even thousand-foot levels. Similarly in airport traffic control, planes are "stacked" with individual thousand-foot altitude separations, pending clearance to land.

Barometric switches in the aircraft equipments automatically set the challenger's altitude coder and the replier's altitude decoder for the code assigned to the lamina involved. At the pilot's option, a manual coder control in the aircraft challenger may be used in place of the barometric switch to examine traffic conditions in any other lamina, when necessary. The altitude decoders of hazard beacons are permanently set to accept challenger signals from all laminas up to a clearance level 1000 ft. above the top of their obstruction, and the altitude coders of traffic control challengers are sequentially switched at a visually persistent rate through all laminas up to 13,000 feet.

To provide ample safety margin above and below each plane, the altitude code changes not at whole-number thousand-foot levels (1000 feet, 2000 feet, 3000 feet, etc.), but at the intermediate levels of 1500 feet, 2500 feet, 3500 feet, etc. Practical applications of the laminar method are illustrated in Figs. 4, 5, and 6.

The anti-collision display for aircraft challengers (Fig. 3) is an L scope showing distance vertically and direction by relative right-and-left pip length. Normal identity coding is seen as intermittent widenings of the reply pips for long and short time intervals corresponding to dashes and dots of International Morse. Since the pip appears as a narrow pulse during all spacing intervals, it never is lost from the screen while the replier is being triggered. The reply coding is sent at a rate of about five words per minute in repeated groups of three or four Morse letters.

At average airports and airway traffic reporting stations equipment needed is slightly different. It would be necessary to have a PPI to show distance and direction, and an A scope to show the reply coding. Altitude may be determined by switching in a manual control, which discontinues the automatic series of coding sequences, and sets the challenger's coding steadily for any one lamina desired.

Such a change, of course, temporarily interrupts the surveillance of planes in other laminas, a disadvantage that could not be suffered at large airports. These, therefore, would have to be equipped with separate PPI and A displays for each lamina.

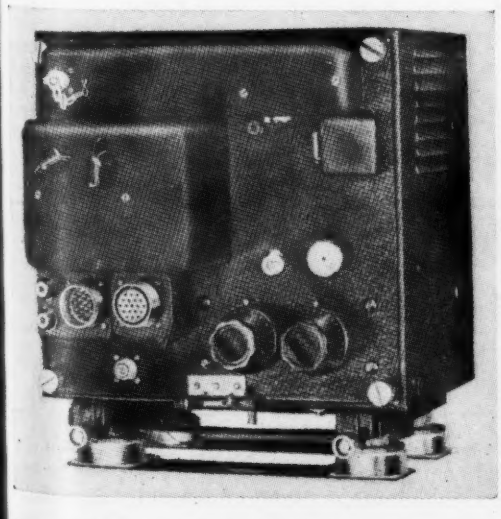
Navigation

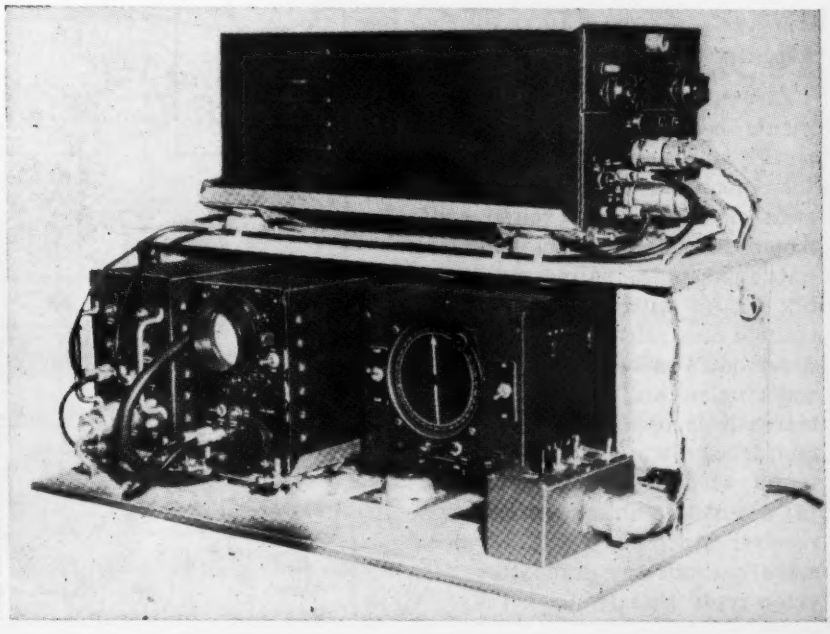
Although a LANAC navigational fix using a directional antenna somewhat resembles the present type of DF (direction finder) fix, the latter requires at least two beacons, while the former requires only one. Two LANAC beacons do establish a better fix when maximum accuracy is desired, but a single-replier fix is close enough for most practical purposes. To prevent confusion, neighboring replier beacons in the navigational service would not use the same transmitting frequencies, and while this would require an aircraft pilot to switch to a new receiving frequency every half hour or so, the process is simplified by present tuning in all LANAC equipments on 12 challenge and 12 reply channels.

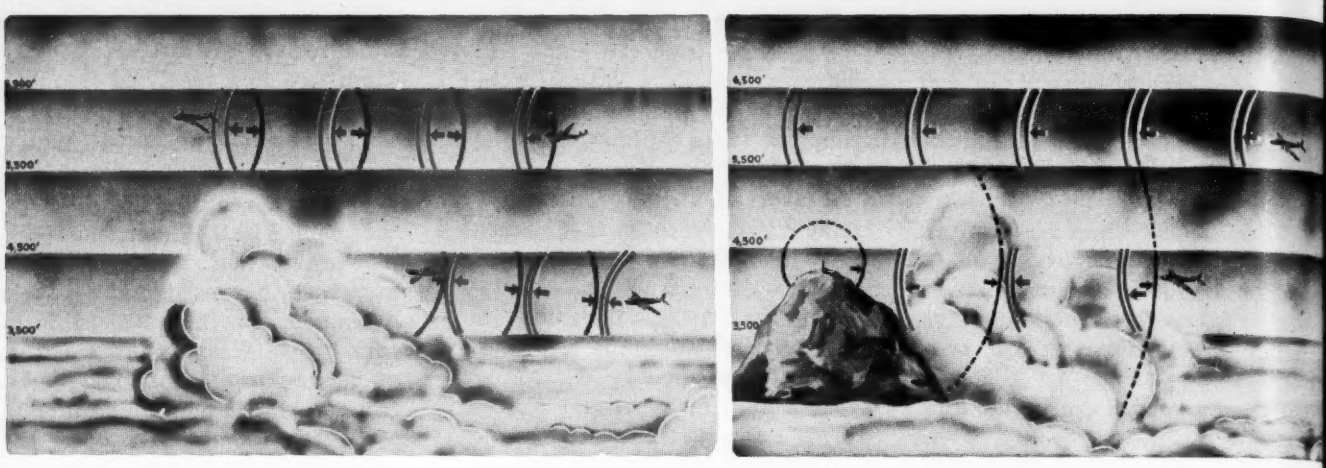
In using LANAC for point-to-point navigation, altitude coding, as such, is not used and separate challengers on different pairs of radio frequencies are used. While the anti-collision challenger has a rotatable lobe-switching antenna with "front" directivity only, the navigation challenger uses an omni-directional antenna. The latter permits only the beacon's identity and range to be given, but has the advantage of relieving the pilot from making directional adjustments. The navigation beacon's range is shown on a meter instead of a 'scope, and a blinker lamp flashes the Morse identity coding.

Relative bearing may be obtained with ADF (automatic direction finder) or the vhf omnirange stations that already have been adopted as standard navigational aids on all international air-trunk routes. (It is assumed that a navigation replier beacon would be installed in close proximity to each vhf station, so that the latter would simultaneously provide the relative bearing of both.) To obtain the relative bearing of a navigation replier beacon without the vhf omni-range or ADF, the pilot may switch his directional anti-collision challenger over to the required navigation fre-

Airborne challenger with associated equipment shown at right and replier shown below







quencies, and "searchlight" the beacon with his anti-collision antenna, but this temporarily interrupts his collision protection.

Emergency Operation

Distinctive signals that indicate distress are delivered by aircraft and ship repliers in a special type of operation for emergency purposes only. These signals have the same meaning as an SOS, and are returned to all challengers within range, regardless of the challenge codes in use. The emergency signal consists of a set of five pulses spaced eight microseconds apart, whereas normal replies consist of one or two pulses only. Pulse expansion is not used in emergency reply coding, but the fifth pulse of the set is keyed on and off in Morse to identify the sender. Like every other replier function, emergency operation is automatic, and only requires the operator to flip a toggle switch.

Circuits

Circuitwise, the LANAC equipments bear striking resemblances to IFF transpondors and interrogator-responsors. The challenger consists of: (1) a self-excited coder, which initiates the challenge signals and sets the paired-pulse spacing accord with the automatic or manual code selector; (2) an amplifier-modulator, which amplifies the coder pulses and excites; (3) a uhf transmitter oscillator; (4) a common transmitting and receiving antenna, which is usually directional; (5) a sensitive uhf superheterodyne receiver which supplies; (6) one or more cathode-ray indicators with video reply signals.

The replier consists of: (1) a common receiving and transmitting antenna, which is always omnidirectional; (2) a uhf superheterodyne receiver whose output feeds the decoder; (3) the decoder, controlled by the barometric altitude switch (or equivalent manual switches); (4) a modulator, which is triggered by the decoder, initiates the reply pulses, and is controlled for identity coding by (5) an automatic keyer; (6) a uhf transmitter oscillator, which is excited by the modulator.

It may be seen at once that both types of equipment have nearly identical circuits, the major distinction being the reversed orders of signal progression. Challengers and repliers use practically interchangeable rf heads, or "plumbing," units containing all the uhf circuits, and both have 60-mc IF amplifiers with six or seven cascaded stages providing a bandwidth of approximately 12 mc. (This width is needed to accommodate accidental frequency drifts in both equipments, and to preserve the form of the pulses. It is obtained by stagger tuning in most of the challenger IF strips, and by feedback methods in the repliers.) The modulators are often alike, differing chiefly according to power

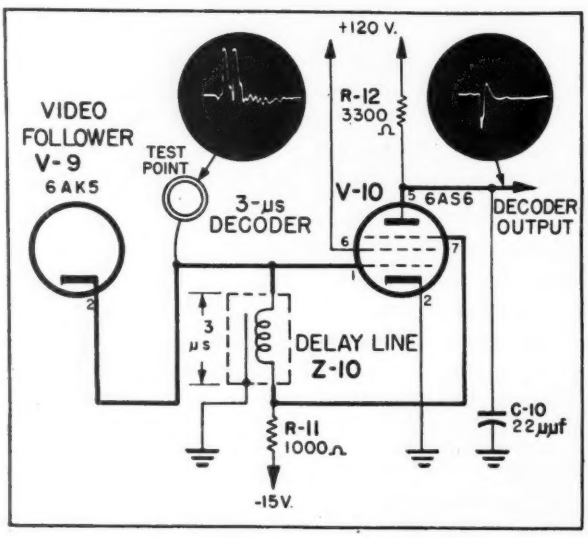
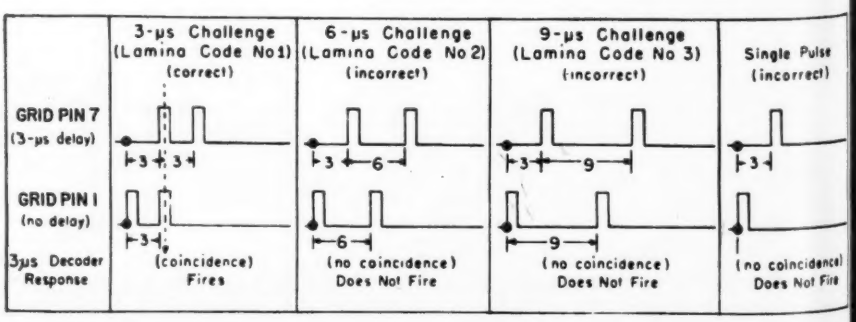
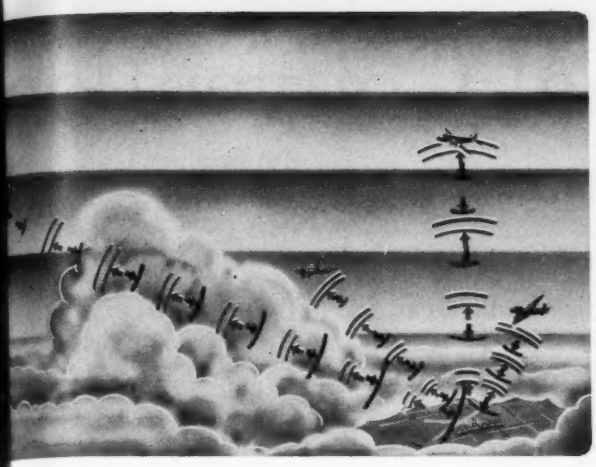


Fig. 7—Coder's schematic simplified basic circuit. Method of establishing paired pulse spacing is explained on diagram

Fig. 8—Basic circuit of a typical replier decoder. Method of rejecting improperly coded pulses is shown on the diagram. Tubes V-1 to V-3 constitute a spacing circuit for only one challenge code, similar circuits for other codes being switched in and out by switch S-1. The two pulse generators V-4 and V-5 are common to all circuits





Figs. 4, 5 & 6, left to right—Practical application of the laminar method showing first, airplanes challenging only others in their own height layer; second, obstacle warnings going only to planes below a safe elevation; third ground controllers separately investigating various height layers to determine interferences

output. Dissimilarities are found, of course, in the challenger's coder, which is diametrically the opposite of the replier's decoder, and in the replier's keyer (similar in principle to the omnigraph code practice unit), which has no counterpart at the challenger.

A simplified schematic coder's basic circuit is shown in Fig. 7, where the method of establishing the paired-pulse spacing is explained on the diagram. Tubes V-1, V-2, and V-3 constitute a spacing circuit for only one challenge code, similar circuits for other codes being switched in and out by S-1. The two pulse generators, V-4 and and V-5, are common to all spacing circuits, and feed their outputs into the modulator through a common conductor.

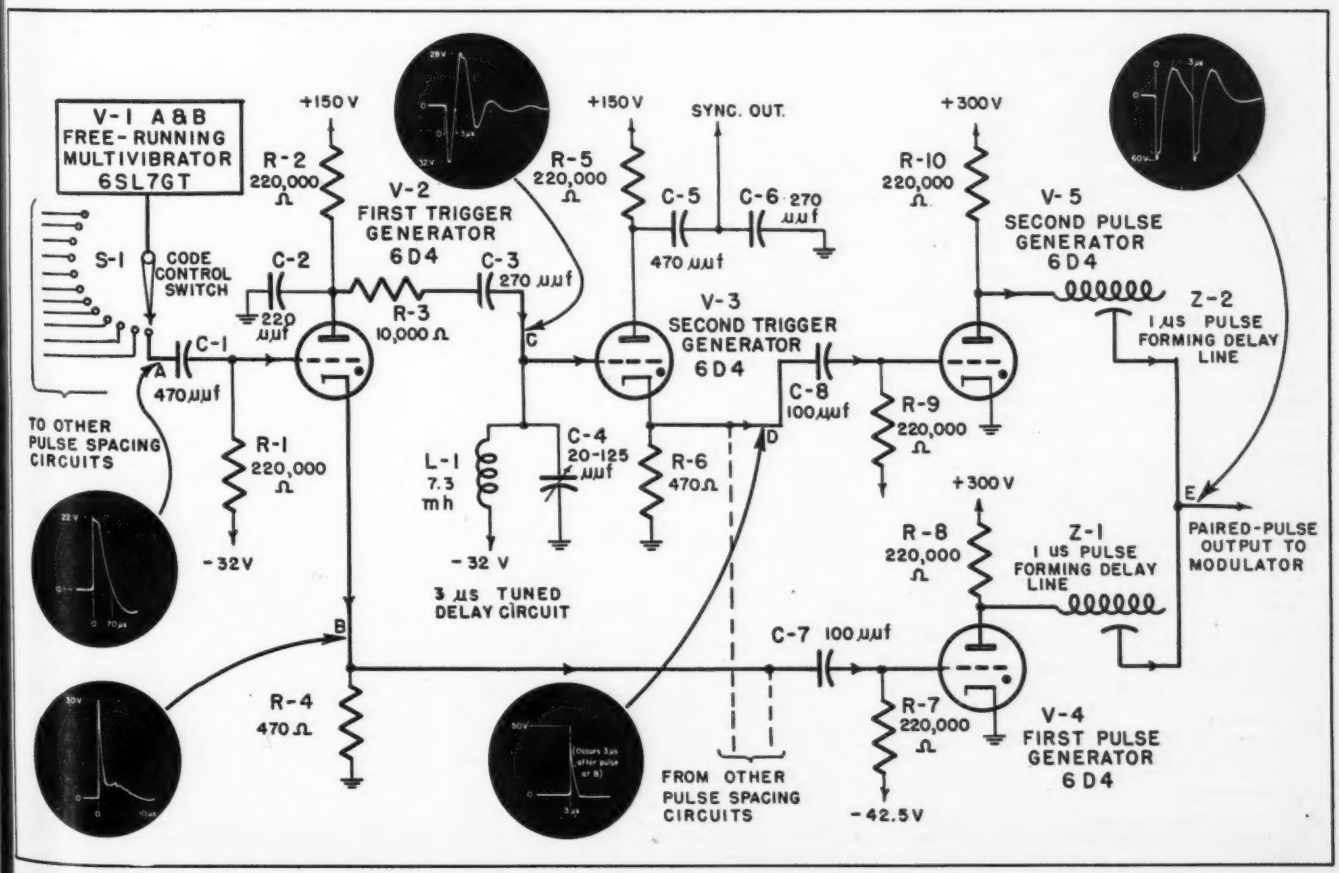
The other simplified schematic, Fig. 8 presents the basic circuit of a typical replier decoder. Here the method of rejecting improperly coded pulses is also shown on the diagram. Again, the three-microsecond circuit is switched out, when necessary, in favor of similar circuits for other challenge codes, though the switch itself is not represented.

Challengers use two forms of automatic gain control, gating and *gain time control* (GTC), to clarify the display. Both of these are electronic switching circuits that minimize clutter by attenuating receiver gain to a no-reception level when replier answers are not wanted, and by providing the proper gain at the proper time, i.e., during the search period immediately after each paired-pulse transmission. Both circuits are triggered into action by synchronizing pulses from the challenger's coder, and each accomplishes its purpose by applying a varying bias to the grids of one or more IF tubes.

Gating Circuit

The gating circuit usually is a "one-shot" multivibrator, which supplies a cut-off bias to the IF grids during its stable state, and then removes the bias when it is triggered into its oscillatory cycle. Reception thus is permitted while the cycle persists—for an adjustable length of time corresponding to the range being searched—but the bias is reapplied as soon as the multivibrator returns to quiescence. This reduces the average noise output, and keeps superfluous signals from distant repliers off the scope screen.

(*Continued on page* 129)



IRE 1947 National Convention

Five-day gathering, scheduled for March 3-7 at Commodore, to include 125 papers in 24 categories—Exhibition at Grand Central Palace

● The Institute of Radio Engineers' 1947 National Convention will be big, the most important gathering of electronic engineers of the year. As such it will spread over five days. The theme of the convention is "Electronics at Peace".

Under some 24 categories completely covering every phase of radio and electronic applications to communications and industrial processes, there are to be more than 125 technical papers, lectures and demonstrations. Most of these sessions are to be held in the commodious hotel Commodore. Thus convention meetings will be removed only a short distance from Grand Central Palace which is to house the exhibition where facilities also are available for some of the lectures and demonstrations of electronic equipment, parts and components.

IRE President Dr. W. R. G. Baker, vice-president of GE, receives Certificate of Appreciation from Brig-Gen. Arnold

That exhibition, incidentally, will hold the exhibits of nearly 200 manufacturers. The exhibits will be open to members from Monday afternoon at 1 o'clock, March 3, until Thursday night, March 6, each night until 10 o'clock, except on Wednesday, the night of the big annual banquet, when the exhibits will be closed at six o'clock.

Technical sessions start at the Commodore on Monday morning March 3, all papers being presented for the first time and none having been previously published in any form.

MONDAY, MARCH 3

Particle Accelerators for Nuclear Studies

Particle Accelerators for Nuclear Studies—G. W. Dunlap (GE)
FM Cyclotron—W. Salisbury (Collins)
The Betatron—T. M. Dickinson (GE)
A 70 MEV Synchrotron—A. M. Gurewitsch, H. C. Pollock, R. V. Langmuir, F. R. Elder, J. P. Blewett (GE)
The Linear Accelerator—J. C. Slater (MIT)

Electronic Measuring Equipment

A Method of Determining and Monitoring Power and Impedance at High Frequencies—J. F. Morrison and E. L. Younker (Bell Tel.)
Theory of Measurement of Dielectric Properties at 10,000 mc sec.—C. V. Larrick (GE)
A Coaxial-Line Noise Source of Ultra-High-Frequency—H. Johnson (RCA)
A New Reactance-Tube Distortion and Noise Meter—C. W. Clapp (GE)
Cathode Ray Presentation of Three-Dimensional Data—O. H. Schmitt (Airborne Instr. Lab.)

Radar & Communication Systems

Shipboard Radar Fire Control from the System Viewpoint—Robert M. Page and John B. Trevor, Jr. (Naval Research Lab., Wash., D. C.)
System Considerations in the Design of VHF and SHF Communication Circuits—E. Fubimi (Airborne Instr. Lab.)
Portable Military Communication Set—C. E. Sharp (Coles Signal Lab.)
Carrier Current Dialing Over Long Distance Telephone Circuits—Imre Molnar (Automatic Electric)
Caesium Vapor Lamps in Infrared Communication—M. C. Beese (Westinghouse Elec.)

FM Reception

FM Detector Systems—B. D. Loughlin (Hazeltine Electronics)
Broadband FM Detector for Multi-Channel Communication—J. W. Albersheim (Bell Tel.)
Method for Measurement of Instantaneous Frequency of an FM Oscillator—L. E. Hunt (Bell Tel.)
A Variable Phase Shift Frequency Modulated Oscillator—O. E. DeLange (Bell Tel.)
Linearity in Tuned Transformer Frequency Discriminator—H. R. Summerhayes, Jr. (GE)

TUESDAY, MARCH 4

Aids to Navigation

Relations Between Bandwidth, Speed of Indication, and Signal-to-Noise Ratio in Radio Navigation and Direction Finding—H. Busignies and M. Dishal (Federal Telecommunication)
Targets for Microwave Radar Navigation—S. D. Robertson (Bell Tel.)
A Comparison of Interrogation by Search Radars and by Separate Interrogators in Pulse Transpondor Systems—F. A. Darwin (Hazeltine Electronics)
Low Frequency Loran—V. S. Carson, S. Seton, M. Rothman, M. Pomerantz (Watson Labs.)
Elimination of Precipitation Static—W. H. Bennett (Nat'l Bur. of Standards, Wash., D. C.)

Nucleonics Instrumentation

Nucleonics Instrumentation—V. C. Wilson (GE)
Proportion Counters and Geiger Counters—S. Korff (N.Y.U.)
Cloud Chambers—G. C. Baldwin (GE)
Applications of the Vibrating Reed Electrometer—W. P. Jesse (Argonne Nat. Lab., Chicago)
Pulse Amplifiers for Ionization Detection—M. Sands (MIT)

Microwave Components and Test Equipment

Experimental Determination of Helical Wave Properties—C. C. Cutler (Bell Tel.)
A Stabilized Magnetron for Beacon Service—C. P. Vogel, J. S. Donal, Jr., B. B. Brown, C. L. Cuccia, W. J. Dodds (RCA)
Coupled Circuits Used as Tunable Band-Pass Filters in the Ultra-High-Frequency and Microwave Region—R. O. Petrich (Airborne Instruments Labs.)
Broad-Band Ultra-High-Frequency Amplifiers—A. M. Levine and M. G. Hollobaugh (Federal Telecommunication Labs.)
The Measurement of Delay Distortion in Microwave Repeaters—D. H. Ring (Bell Tel.)

Television A

Synchro-lite for Television Film Projectors—L. C. Downes and J. F. Wiggin (GE)
Video-Frequency Negative-Feedback Amplifiers—M. G. Hollobaugh and A. M. Levine (Federal Telecommunication Lab.)
Radio Frequency Performance of Some Receiving Tubes for Television—R. Cohen (RCA)
Theory of Multi-Stage Wide-Band Amplifier Design—W. E. Bradley (Philco)
Recent Advances in the Design of Intermediate Frequency Amplifiers for Television Receivers—C. Marsh (A. B. DuMont)

Television B

Cathode Ray Tubes and Optical Systems—H. Rinia, J. DeGier, P. M. Van Alphen (N. V. Philips' Gloeilampenfabrieken, Eindhoven, Holland)
High Voltage Unit and Deflection Circuit—J. Hanntzes, G. J. Siezen and F. Kerkhof (N. V. Philip's Gloeilampenfabrieken, Eindhoven, Holland)
Cathode-Ray Flying-Spot Scanner for Television Signal Generation—R. D. Kell and G. C. Sziklai (RCA)
Gas-Discharge-Tube Television Deflection System—K. R. Wendt (RCA)
An Improved Counter-Timer for Television—C. E. Hallmark (Farnsworth)

Electronic Digital Computers

The Electronic Digital Computers—J. W. Forrester (MIT)
Input Mechanisms for Electronic Digital Computers—S. N. Alexander (Nat'l Bur. of Standards, Washington, D. C.)
Electronic Computing—H. H. Goldstine (Institute for Advanced Study)
A Tube for Selective Electrostatic Storage—J. A. Rajchman (RCA)
Applications of Electronic Digital Computers—P. Crawford (Special Devices Division, Office of Naval Research, Wash., D. C.)

Power Output Vacuum Tubes

Screen Grid Transmitting Amplifier Tubes for Operation up to 500 mc sec.—W. G. Wagener (Eitel-McCullough)
A New FM and Television Power Amplifier Tube and Its Associated Grounded Grid Cavity Circuit—H. D. Wells and R. I. Reed (GE)

Frequency Modulation and Control by Electron Beams—L. P. Smith and C. Shulman (RCA)
A Frequency-Modulated Magnetron for Super-High Frequencies—G. R. Kilgore, C. Shulman, J. Kurshon (RCA)
A One-Kilowatt Frequency-Modulated Magnetron for 900 mc/sec.—J. S. Donal, Jr., R. R. Bush, C. L. Cuccia, H. R. Hegbar (RCA)
New Technic in Glass to Metal Sealing—J. A. Pask (Westinghouse Elec.)
Determination of the Mutual Heating of Helical Filaments—M. Youdin (Amperex Electronic)

Circuit Theory

Phase and Amplitude Distortion in Linear Networks—M. J. DiToro (Microwave Research Inst., Polytechnic Institute)
Correlation of Network Frequency Response and Square Wave Shape—R. Lee (Westinghouse)
Compensation of Phase Shift at Low Frequencies—F. McGee (Federal Telecommunication)
Parabolic Loci of Coupled Circuits—S. H. Chang (Watson Labs., Cambridge, Mass.)
Reciprocity Failure in Crystal Networks—L. Apker, E. Taft, and J. Dickey (GE)

WEDNESDAY, MARCH 5

Electronic Controls and Applications

Electronic Control in Industry—G. M. Chute (GE), Detroit, Mich.
Variable Radio Frequency Follower System—R. F. Wild (Brown Instrument Co.)
Continuous Recording Sensitive Magnetometer—R. F. Simmons (Airborne Instr. Lab.)
Three Dimensional Representation on Cathode-Ray Tubes—C. Berkley (DuMont)
New Electronic Wiring Techniques—C. Brunetti (Nat'l Bur. of Standards)

Aids to Air Navigation and Traffic Control

The Function of Air Traffic Control—W. White (Airborne Instr. Lab.)
Trends in Air Navigation—H. Davis (Watson Labs., Red Bank, N. J.)
Hazeltine Lanac System (Laminar Air Navigation Anti-Collision)—K. McIlwain (Hazeltine)
First Tests on Navar System for Aerial Navigation and Air-Traffic Control—H. Busignies and P. A. Adams (Federal Telecommunication)
The Application of Microwaves to the Guidance and Control of Aircraft—J. Lyman and G. Litchford (Sperry Gyroscope)

Microwave Technic and Measurements

Precision Measurements of Impedance Mismatches in Wave Guide—A. F. Pomeroy (Bell Tel.)
A Coaxial Line Support for 0-4000 mc—R. W. Cornes (Sperry Gyroscope)
Power Leads at Very and Ultra High Frequencies—A. G. Kandoian and R. A. Felsenheld (Federal Telecommunication)
Direct Reading Wavemeters—G. E. Feiker and H. R. Meahl (GE)
The Operational Behavior of a Magnetron Microwave Generator When Coupled to a Long Transmission—W. C. Brown (Raytheon)

Broadcasting and Recording

Propagation Characteristics of the UHF (480-920 mc) Television Band—W. B. Lodge (Columbia Broadcasting System)
Theoretical and Practical Aspects of FM Broadcast Antenna Design—P. H. Smith (Bell Tel.)
Monitoring Equipment for FM Broadcasting—M. Silver (Federal Telecommunication)
Ultra-High-Frequency Multiplex Broadcasting System—A. G. Kandoian and A. M. Levine (Federal Telecommunication)
Field Measurements on Magnetic Recording Heads—D. L. Clark and L. L. Merrill (Stromberg-Carlson Co.)

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Oscillator Circuit Theory

Limitations of the Superregenerative Circuit—H. Stockman (Cambridge Field Station, Cambridge, Mass.)
Theory of Amplitude Stabilized Oscillators—P. R. Aigrain and E. M. Williams (Carnegie Institute of Technology, Pittsburgh)
Synchronization of Oscillators—R. D. Huntoon and A. Weiss (Nat'l Bureau of Standards, Washington, D. C.)
Operating Characteristics of Coupled-Circuit Oscillators—D. K. Cheing (Cambridge Field Station)

Basic Electronic Research

The Electronic Research Sponsored by the Office of Naval Research—E. R. Piore (Navy Dept., Office of Naval Res., Wash., D. C.)
Spherical Aberration of Compound Magnetic Lenses—L. Marton (Nat'l Bur. of Standards), K. Bol (Stanford Univ., Calif.)
Field Emission Arc as an Electron Source—C. M. Slack and D. C. Dickson (Westinghouse)
Response of a Thermionic Vacuum Tube to the Sudden Application of an External Voltage—E. H. Gamble (Polytechnic Institute of Brooklyn)
Noise-Suppression Characteristics of Pulse Modulation—S. Moskowitz and D. D. Grieg (Federal Telecommunication Labs.)

Wave Propagation and Antennas

A Study of Tropospheric Reception at 42.8 mc and Meteorological Conditions—G. W. Pickard and H. T. Stetson (MIT)
Results of Microwave Propagation Tests on a 40-Mile Overland Path—A. L. Durkee (Bell Tel.)
A Method of Rapid Continuous Measurement of Antenna Impedance Over a Wide Frequency Range—H. V. Cottony (Nat'l Bur. of Standards, Wash., D. C.)
A Phase-Front Plotter for Centimeter Waves—H. Iams (RCA)
Aircraft Antenna Pattern Measuring System—O. H. Schmitt (Airborne Instruments)

Relay and Pulse Time Systems of Communication

Consideration of Moon Relay Communications—H. Busignies and D. D. Grieg (Fed. Telecommunication)
Experimental Studies of a Remodulating Repeater System—W. M. Goodall (Bell Tel.)
Experiences with Multipath Transmissions at VHF, UHF, and SHF—F. P. Morf (Coles Signal Lab., Red Bank, N. J.)
Multiplex Employing Pulse Time and Pulsed FM Modulation—H. Goldberg and C. C. Bath (Bendix Radio, Baltimore, Md.)
Multiplex Microwave Radio Applied to Telephone Systems—T. H. Clark (Fed. Telecommunication)

Receiver Circuits

Synchronous Detectors—J. G. Reid, Jr. (Nat'l Bur. of Standards, Washington, D. C.)
A Wide Band 550-Megacycle Amplifier—R. O. Petrich (Airborne Instruments)
A Compact Electro-Mechanical Filter for the 455 KC I.F. Channel—R. Adler (Zenith Radio)
Receiver Sensitivity at the Higher Frequencies—J. M. Pettit (Airborne Instr.), now at Stanford University, Calif.

Vacuum Tubes and Gas Rectifiers

Beam Deflection Control for Amplifiers and Mixers—Part I: High Transconductance Design Considerations—G. R. Kilgore (RCA); Part II: Mixer Tubes for Ultra-High Frequency—E. W. Herold, C. W. Mueller, H. A. Finke (RCA)
A New 100-Watt Triode for 1000 Megacycles—W. R. Keye, C. E. Haller, E. A. Eschbach, W. P. Bennett (RCA)
A Study of Microphonics in a Sub-Miniature Triode—V. W. Cohen and A. Bloom (Nat'l Bur. of Standards, Washington, D. C.)
Design of Gas-Filled Cold-Cathode Tubes—G. C. Rich (Sylvania)
Recent Advances in High Voltage Rectifiers for Television Receivers—G. Baker (Chatham Electronics, Newark, N. J.)

Antennas

Fundamental Limitations of Small Antennas—H. A. Wheeler (Consulting Radio Physicist, Great Neck, N. Y.)
Helical Antenna for Circular Polarization—H. A. Wheeler (Consulting Radio Physicist, Great Neck, N. Y.)
The Directly-Fed Vertical Stabilizer as a Zero-Drag Broad-Band Aircraft Antenna for HF and VHF—R. S. Wehner (Airborne Instruments)
Antennas for Modern Transport Aircraft—R. S. Wehner (Airborne Instruments)
A Study of Networks Useful in Broad-Banding and Diplexing Turnstile Antennas for Television Transmission—G. H. Brown, J. Epstein, D. W. Peterson and O. M. Woodward, Jr. (RCA)
Radiation Patterns of Thick End-Fed Antennas—C. H. Page and R. D. Huntoon, P. R. Carr (Nat'l Bureau of Standards, Washington, D. C.)
A New Type of Broad-Band Zero-Drag Aircraft Antenna—A. Dorne and J. Margolin (Airborne Instruments)
Circularly Polarized Antennas—W. Sichak and S. Milazzo (Federal Telecommunication)

Wave Guide Technics

An Adjustable Wave Guide Phase Changer—A. G. Fox (Bell Tel.)
Developments in Broadbanding of Microwave Plumbing Components—J. H. Vogelman (Watson Labs., Red Bank, N. J.)
A Consideration of Directivity in Waveguide Directional Couplers—S. Rosen and J. T. Bangert (Bell Tel.)
Electrical Measurements on Transmission Cavity Resonators at 3 cm Wavelength—M. S. Wheeler (Westinghouse)
Design of a Resonant Cavity for Frequency Reference in the 3 cm Range—R. R. Reed (Westinghouse)

EXHIBITORS AT IRE'S PALACE EXHIBITION

Airadio Inc., Melrose Ave. & Barry Place, Stamford, Conn.
Aircraft Radio Corp., Boonton, N. J.
Allied Control Co. Inc., 2 East End Ave., New York
Alpha Metals, Inc., 363 Hudson Ave., Brooklyn, N. Y.
Alpha Wire Corp., 50 Howard St., New York
Altec Lansing Corp., 250 W. 57th St., New York
Amperex Electronics Corp., 79 Washington St., Brooklyn, N. Y.
American Lava Corp., Chattanooga 5, Tenn.
American Phenolic Corp., 1830 S. 54th Ave., Chicago
American Transformer Co., 178 Emmet St., Newark 5, N. J.
Andrews Co., 363 E. 75th St., Chicago
Astatic Corp., P. O. Box 120, Conneaut, Ohio
Audio Development Co., 2833 13th Ave. S., Minneapolis
Audio Devices, Inc., 444 Madison Ave., New York
Automatic Mfg. Co., 900 Passaic Ave., East Newark, N. J.

Ballantine Laboratories, Inc., Boonton, N. J.
Barker & Williamson, Upper Darby, Pa.
Boonton Radio Corp., Fanny Rd., Boonton, N. J.
William Brand & Co., 276 Fourth Ave., New York
Brush Development Co., 3311-25 Perkins Ave., Cleveland
Burlington Instrument Co., Burlington, Iowa
Bird Electronic Corp., 1800 E. 38 St., Cleveland

Cambridge Thermionic Corp., 445 Concord Ave., Cambridge 38, Mass.
Centralab, 900 East Keefe Ave., Milwaukee
Chatham Electronics, 475 Washington St., Newark 2, N. J.
Chicago Transformer, 3501 Addison St., Chicago
Cleveland Container Co., 6201 Barberton Ave., Cleveland
Sigmund Cohn Co., 44 Gold St., New York
Collins Radio Co., 11 W. 42nd St., New York
Communication Measurements Lab., 120 Greenwich St., New York
Condenser Products Co., 1369-75 N. Branch St., Chicago
Cornell-Dubilier Elec. Corp., 1000 Hamilton Blvd., S. Plainfield, N. J.
Cornish Wire Co., Inc., 15 Park Row, New York

Daven Co., 191 Central Ave., Newark 4, N. J.
De Mornay-Budd Inc., 475 Grand Concourse, Bronx 51, N. Y.
Tobe Deutschmann Corp., Canton, Mass.
Distillation Products, Inc., 755 Ridge Rd., W., Rochester 13, N. Y.
S.S.R. Ducati-Milano (Italy), 521 Fifth Ave., New York
Allen B. DuMont Labs. Inc., 515 Madison Ave., New York

Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Eitel-McCullough Inc., 798 San Mateo Ave., San Bruno, Calif.
Electrical Reactance Corp., 49 Elm St., Franklinville, N. Y.
Electronic Labs Inc., 122 W. New York St., Indianapolis
Electronic Mechanics, 70 Clifton Blvd., Clifton, N. J.
Electronics Research Publ. Co., 2 W. 46 St., New York
Electro-Voice, Inc., 1239 South Bend Ave., South Bend 24, Ind.
Erie Resistor Corp., Erie, Pa.

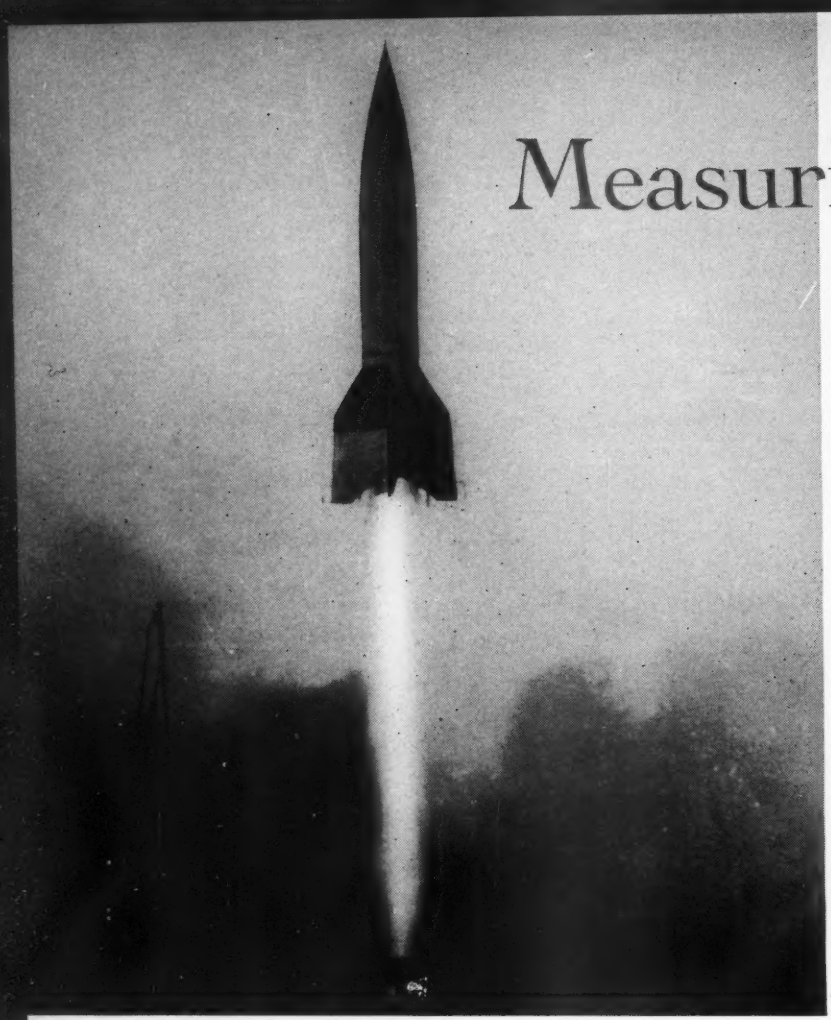
Fairchild Camera & Instrument Co., 88-06 Van Wyck Ave., Jamaica 1, N. Y.
Fansteel Metallurgical Corp., North Chicago, Ill.
Federal Telephone & Radio Corp., 67 Broad St., New York
Ferris Instrument Co., 110 Cornelia St., Boonton, N. J.
Finch Telecommunications Inc., 10 E. 40 St., New York
A. W. Franklin Mfg. Corp., 43-20 34 St., Long Island City, N. Y.

(*Continued on page* 131)

Measuring Velocity of

By J. F. McALLISTER, Aeronautic & Marine Div.
General Electric Co., Schenectady, N. Y.

Details of high velocity measurement technics developed by German scientists



One of the captured German V-2 rockets, reassembled by American engineers, just after it left the ground in tests in New Mexico

● The V-2 rocket was the most dramatic technical achievement of the Germans during the last war. Descending from altitudes never before reach by man-made devices, at velocities such that no defense was possible at the time, these rockets were recognized as potentially extremely significant, and lent disturbing contours to the shape of things to come.

In Fig. 1 is drawn a trajectory typical of those used in flights aimed at London. Until the time of fuel cut-off, the missile was gyro stabilized in pitch, roll, and yaw. Beyond this point all gyros became inactive, and the rocket proceeded to its point of impact as a freely moving body.

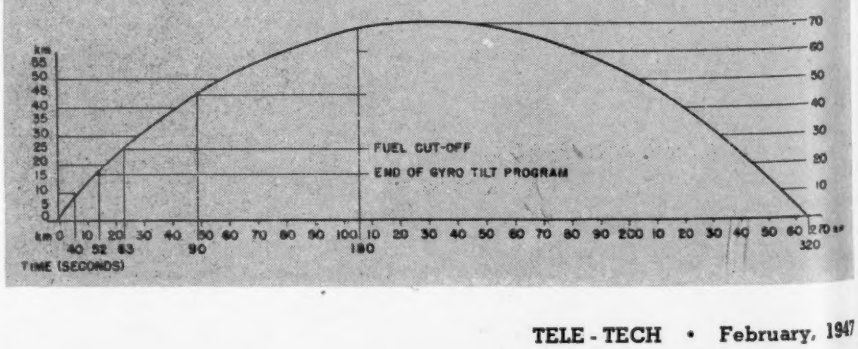
Without going into details or second order effects, one may say that three conditions had to be fulfilled at fuel cut-off in order for the missile to reach a predetermined target. First, it had to be headed along the proper azimuthal line; second, a specific angle between its velocity vector and the vertical must be achieved; third, depending on this angle and the target distance, a unique velocity value was required

The first of these conditions was fulfilled in a manner similar to that of conventional artillery technic—that is, the rocket was aimed in the proper azimuth direction while it rested on the launching platform. During powered flight, even though vertical inclination was varying, the azimuth gyro-servo system merely maintained the original azimuth aim.

ABOUT one-third of the rockets launched against England utilized the Doppler system for cut-off control. Integrating accelerometers were used in the rest. These simplified the equipment, personnel, and coordination required in launching, and, of course, avoided the possibility of enemy interference. The average range accuracy for Doppler-controlled flights, according to German observations and analysis, was plus or minus 0.9 miles in 160.

The second and third conditions, however, were fulfilled in a manner opposite to that used in artillery practice. Normally, the muzzle velocity of a projectile is known and fixed. To vary range, one varies the angle of elevation. In the case of the V-2, the elevation angle was fixed. All rockets were fired vertically, but the pitch gyro was controlled by a timing mechanism un-

Fig. 1—Trajectory of V-2 rocket typical of those used in flights aimed at London



V-2 Rockets by Doppler Effect

til a fixed inclination to vertical was reached in all flights. This inclination, once achieved, was maintained until acceleration brought the rocket to the required final velocity. At this instant fuel cut-off occurred, all stabilization was removed, and the missile became a conventional projectile.

It was necessary, therefore, to incorporate a velocity measuring system into all flights. This system had to be highly accurate (range varies as the square of "muzzle velocity") and, to eliminate human response times, it had to be completely automatic. Two basic technics were developed for this purpose. One method utilized airborne integrating accelerometers of electro-mechanical design. Once under way, rockets incorporating these instruments were completely free of any ground control. The other method utilized the Doppler effect, and called for tight-knit coordination with ground activities. It is the purpose of this paper to elaborate somewhat on the latter system.

Doppler Theory

The Doppler effect has been known for a long time. With regard to sound waves, experiments were recorded as early as 1881. In the *General Electric Review,* August, 1936, C. W. Rice describes an early centimeter wave system which could measure automobile velocities at short ranges. (This paper was referred to in German documents prepared for V-2 development.) Theory shows that when a transmitter radiates a frequency (f) and wavelength (λ), the frequency measured by a system whose velocity relative to the transmitter is v, will be:

$$f' = \frac{c - v\cos\alpha}{\lambda} = f - \frac{v\cos\alpha}{\lambda}$$

where c is the velocity of light, and α is the angle between the outward pointing radius vector and the instantaneous velocity vector. Fig. 2 illustrates the geometry involved.

With the above fundamental equation, and the block diagram of Fig. 3, the *modus operandi* of the German system is easily understood. A crystal-controlled, cw ground transmitter radiated a frequency f. In the rocket, this was picked up as a frequency $(f - v\cos\alpha/\lambda)$. This frequency was doubled and reradiated, so that the frequency transmitted by the rocket, *measured on the rocket,*

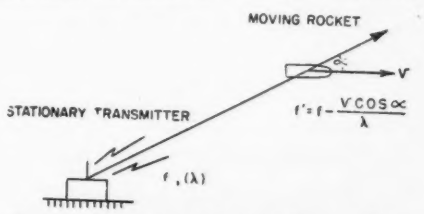


Fig. 2—Fundamental equation and geometry involved in basic Doppler shift

was $2(f - v\cos\alpha/\lambda)$. Another Doppler shift occurred on the way back, since the ground station was effectively in motion with respect to the rocket. Hence, the frequency picked up by the ground receiver was $2(f - 2v\cos\alpha/\lambda)$. This signal was amplified and beat against the second harmonic of the original transmitter frequency. The useful beat, obtained after filtering off high frequency components, was an audio tone of value

$$f_B = \frac{4v\cos\alpha}{\lambda}$$

Since the initial part of the trajectory was pre-set, $\cos\alpha$ was known; hence, this equation specifies velocity in terms of measured beat frequency. Note that for a velocity of 1500m/s (about maximum for the V-2), and a wavelength $\lambda =$ 10m. the beat had a value 600 c/s when $\cos\alpha = 1$.

The Doppler system can provide more information than velocity alone. It can be used to furnish high - accuracy information on range as well. From the last equation, the time required for the beat note to complete a full cycle is:

$$t = \frac{1}{f_B} = \frac{\lambda}{4v\cos\alpha}$$

The distance along the radius vector through which the rocket moves in this time is:

$$d = (v\cos\alpha)\,t = \frac{\lambda}{4}$$

If the ground station is located

One of the German V-2 rockets being prepared for flight by US Army Ordnance Dept. engineers at the Proving Grounds, White Sands, N. M.

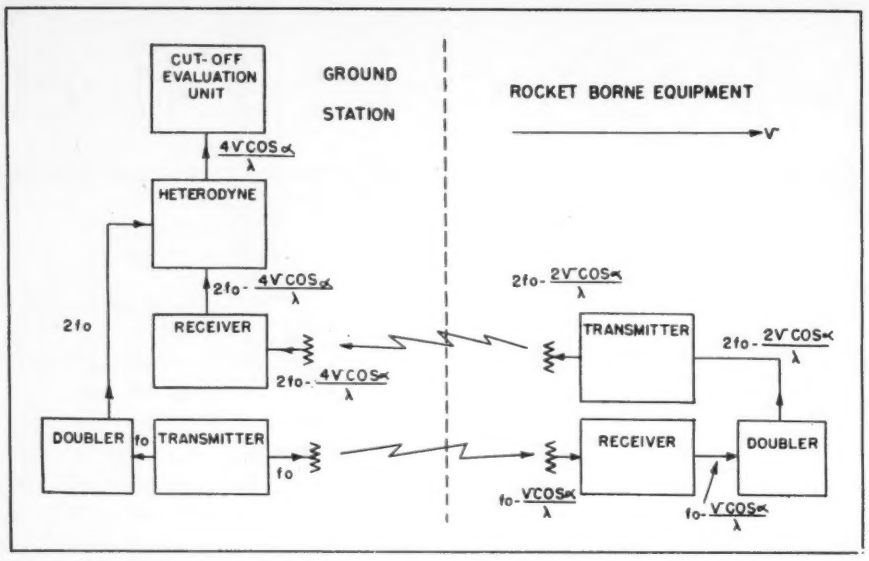


Fig. 3—Block diagram of the German V-2 method of measuring high velocity missiles

behind the launching station, in line with the firing direction, then neglecting earth's curvature, the take-off and impact points are both on the same radius vector. Accordingly the total number of beat cycles recorded during flight, multiplied by $\lambda/4$, is the distance actually traversed by the missile. This information, combined with precision maps, makes correction of range possible on subsequent firings.

When one considers that $\lambda/4$ is only 2.5 meters for $\lambda = 10$, it is easy to appreciate the extreme accuracy potentially available via this method. The Germans, incidentally, did not succeed in fully exploiting this technic before the end of the war, partly because of the difficulty of counting, manually, a number of cycles of the order 10^5.

Conventional Circuits

In general the circuitry was consistent with conventional practice in cw design, as is illustrated by the wiring diagram of the airborne receiver and transmitter (Fig. 4). In this, a low impedance receiving antenna was matched into the first of two rf amplifiers by tuned L-C matching circuits. The incoming frequency was then mixed with the local oscillator frequency to produce the useful IF. This was 1.5 mc, deviated by the Doppler shift, $v \cos \alpha/\lambda$. Two IF stages were used; the second was transformer-coupled into a tuned, split-winding secondary which drove a full-wave rectifier.

The fundamental ripple frequency of the latter's output, of course, was added to augment it. (So far as the author knows, this type of frequency doubling had never before been used at rf levels.) The screen of the local oscillator was coupled to a circuit tuned to its second harmonic. This frequency was combined with the output frequency which was twice the received frequency. Two stages of rf amplification followed, then a matching section, and finally the transmitting antenna. Approximately eight watts of power was radiated.

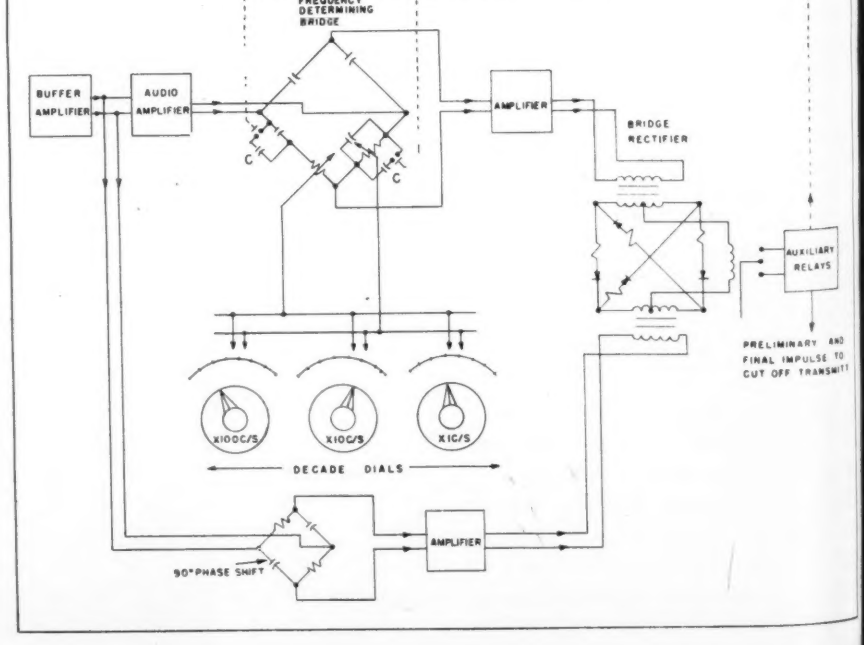
The antenna consisted of two large doors on opposite sides of the rocket, immediately behind the warhead. These were insulated from the rest of the airframe, and served both as receiving and transmitting antennas. Selectivity of the two rf stages, plus the existence of a series-tuned circuit across the grid of the first stage in order to by-pass the doubled frequency, prevented loop regeneration at the second-harmonic level.

Ground Stations

The ground station involved two basic units—the main transmitter, and the cut-off evaluation unit. The main transmitter was crystal controlled. Depending on the frequency to which the air-borne equipment was tuned, any one of the nine different crystals was connected by a selector switch into the oscillator unit. This was done to reduce the possibility of interference or jamming, the range of frequency selection extending from about 28 to 31 mc. The oscillator was followed by a buffer stage and two amplifiers, all sufficiently broadband to accommodate any frequency in the 28-31 mc band.

From this four tube arrangement, 10 watts of driving power was available to a twin-pentode push-pull preamplifier. This delivered approximately 100 watts. Part of this was used to drive a double-pentode, push-pull power amplifier, which supplied approxi-

Fig. 5—Schematic of arrangement of bridge circuits used in velocity measurements



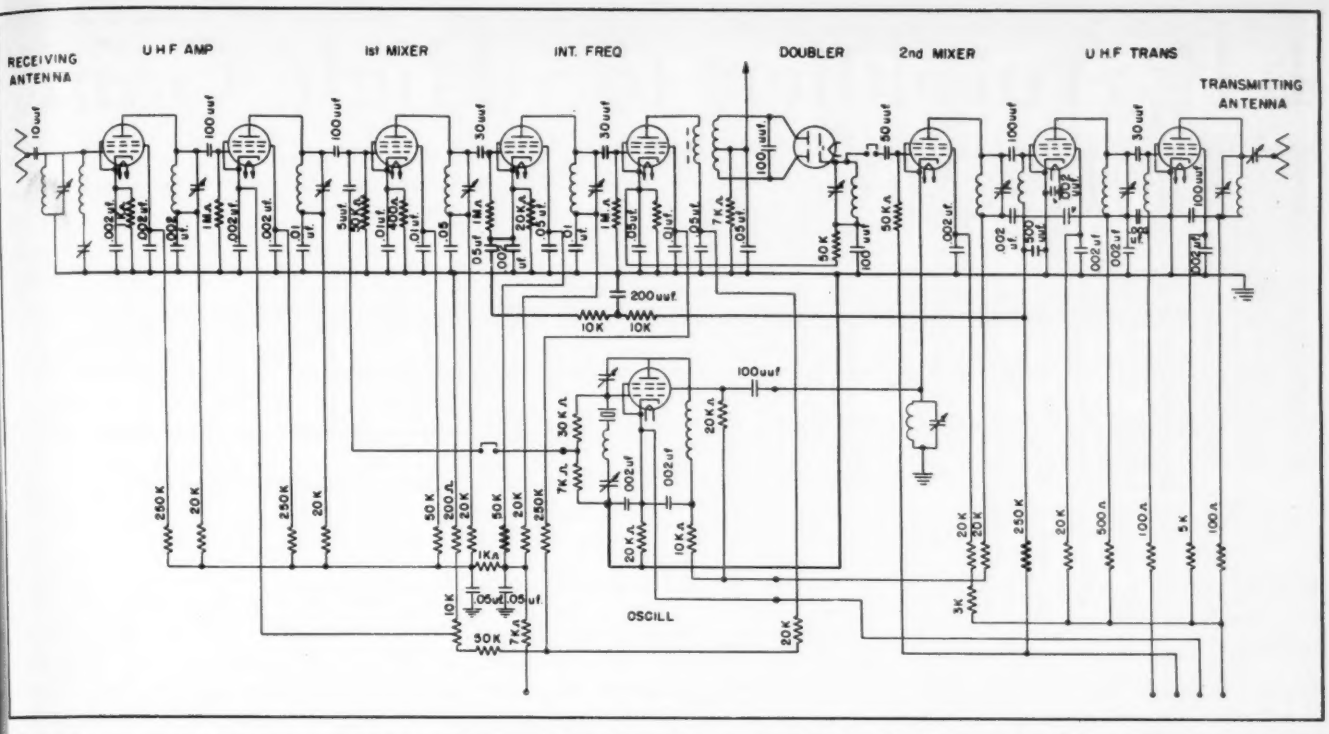


Fig. 4—In general, circuitry was consistent with conventional practice as revealed by this diagram of airborne transmitter-receiver

mately 1000 watts of cw power to a rhombic antenna beamed in the direction of the rocket's trajectory. Another part was used to drive a frequency doubler. The output of the latter was approximately 100 watts at the doubled frequency level, delivered into a coaxial cable connected directly to the cut-off evaluation unit.

The returning frequency, $2(f - 2v\cos\alpha/\lambda)$ was picked up by a separate rhombic antenna associated with the cut-off evaluation unit, and fed into the grid of a broadband rf preamplifier. Its output, plus the doubled frequency received directly from the main transmitter, plus the output of a local oscillator whose frequency was determined by the appropriate one of nine possible crystals, all were fed into a pentode mixer.

The useful IF included two frequencies. One of these was 1.5 mc, obtained from the beat between the local oscillator and the second harmoniously from the transmitter. The other was 1.5 cm minus $4v\cos\alpha\lambda$, obtained from the beat between local oscillator and the signal received from the rocket. These two components were amplified through two stages of if, and fed into a diode peak rectifier. Its output, the envelope of the sum of the two waves just described, was the audio beat note, $4v\cos\alpha/\lambda$. A buffer amplifier followed, whereupon the audio signal was impressed upon the two channels shown schematically in Fig. 5.

It is helpful in this presentation to look ahead at the moment to the bridge rectifier shown in this figure. Direct current flowed from the bridge through the relay coil, the direction of current flow depending on whether the induced voltages in the transformer secondaries were in phase or out of phase. Reversal of current flow caused the relay tongue to move from one contact button to the other.

Bridge Arrangement

In the lower channel, the audio voltage from the buffer was simply shifted 90° by the RC phase-shift network, amplified, and impressed upon one of the two transformers in the bridge rectifier. In the upper channel the audio first passed through two tuned-audio amplifiers to drive a frequency measuring, RC bridge. Such bridges have the property of yielding zero output at some one frequency, and an output which either lags or leads the input by 90° when the frequency is above or below this value.

In the cut-off evaluation unit, the cross-over frequency could be accurately preset by means of decade dials which changed resistance values in two legs of the bridge. The output of the bridge was amplified and impressed upon the other of the two transformers in the bridge rectifier. If the description just given is clear, it should be evident that the voltages induced in the secondaries of the two bridge-rectifier transformers were either in phase or 180° out of phase, the point of change-over occurring when the frequency increased through the value set on the three decade dials. This change of phase, and consequent reversal of dc flow through the solenoid of the polarized relay, was responsible for initiating the cut-off impulse.

In practice, fuel cut-off was carried out in two discreet steps. The first of these reduced the thrust from 25 tons to about 8 tons, thus decreasing the acceleration by a factor of three. Because of this, rate of change of audio frequency was reduced by the same factor, and errors due to transient response were decreased. During the last few seconds of reduced acceleration, "steady-state, ac" conditions, for which the circuits were designed, were more nearly approached, and the effects of incidental delays in the transmission of the final, complete cut-off impulse were reduced.

(*Continued on page* 129)

I-F Amplifier for High Gain FM Receiver

By DAVID W. MARTIN
Communication and Navigation Engineering
Bendix Radio, Towson, Md.

New circuit arrangement provides high sensitivity and selectivity in an FM receiver designed especially for VHF communications service

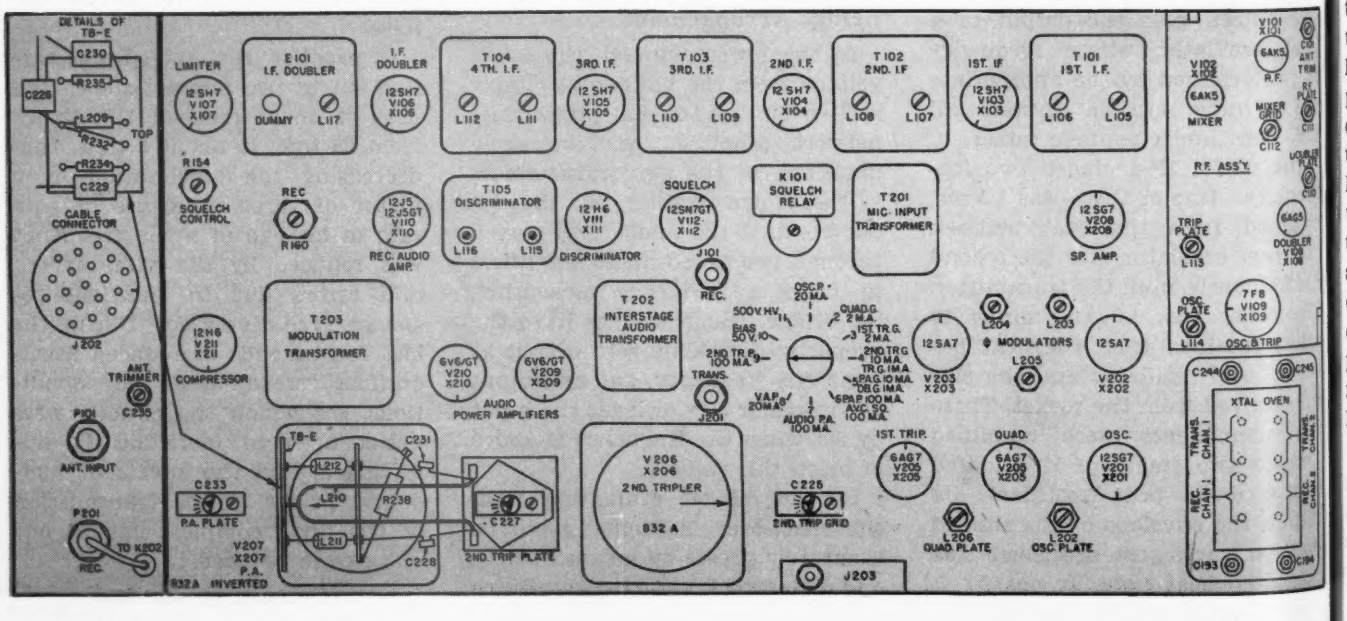
• In planning a high gain, stable FM receiver suitable for mobile emergency services, a new principle of operation to eliminate some of the previous difficulties has been developed by engineers of the Bendix Radio Division. Extensive research and wide experience in the field under practical operating conditions had demonstrated the importance of the following factors in mobile receiver design: (a) High sensitivity to permit complete limiting with inputs well under one microvolt; (b) Ability to reject images and spurious responses; (c) A fast limiter action to counteract impulse noise; (d) Frequency stability under extreme temperature variations (e) Ease of tuning, adjustment and maintenance; (f) Rugged construction to withstand the hardships of mobile service.

OBTAINING the high gain and selectivity required for mobile FM receivers and at the same time providing stable operation has been one of the major problems of receiver engineers. It has been recognized in this respect, however, that the IF amplifier associated with the superheterodyne circuit will deliver high gain by virtue of its fixed frequency advantage, and, simultaneously will contribute a major portion of the required selectivity.

A simple superheterodyne suffers from one severe limitation; it is difficult to obtain sufficient stable gain to make receiver sensitivity less than one microvolt. This fact may not immediately be apparent since AM receivers have been built which use a simple superheterodyne circuit, and give a ten-to-one signal-to-noise ratio well under one microvolt. If the same receiver were converted to FM, however, it would be necessary to add a double limiter in place of the original AM diode detector. This limiter, unfortunately, contributes an additional gain, so that the AM set might have a gain of about one million while the gain of the FM set would be on the order of three to five million. The gain cannot be reduced ahead of the limiter since it takes from 0.5 volt to 2 volts to saturate a limiter.

In the double superheterodyne there are two mixers in cascade. One form uses only one crystal oscil-

View of the top of the Bendix MRT-1B very high frequency communications receiver showing disposition of all components



lator, and mixing is accomplished by using different crystal harmonics on the two mixers. With this setup, it is relatively easy to get the desired stable gain and sharp bandwidth but the spurious response problem is always magnified, and also the first IF must be returned when it is desired to change frequency. The latter difficulty is overcome in the new circuit.

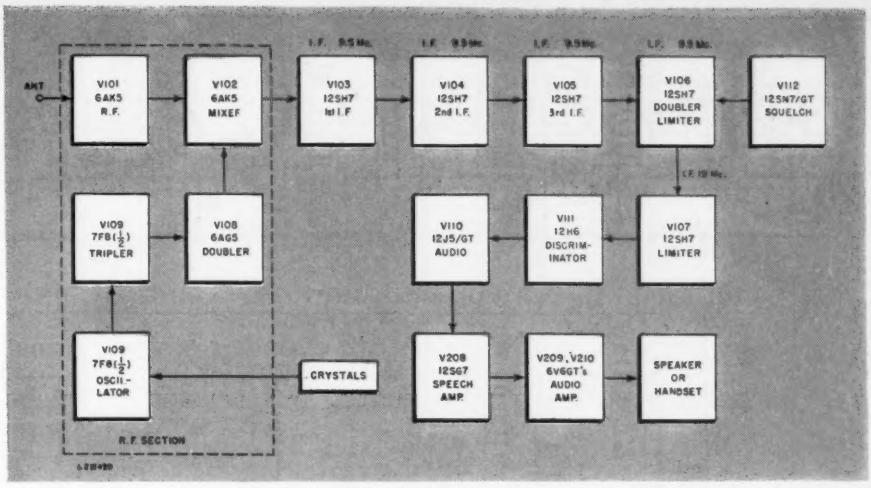
Complications were injected into the Bendix design by space and layout limitations as a previous AM layout that was a part of a complete system was to be retained with a minimum of rearranging. The new design which permitted conversion to FM, had a physical layout as shown in the sketch. The solution was reached by making a fresh approach to the problem, on the basis that in an FM system amplitude distortion in an IF amplifier is of no importance if the original frequency distribution is undisturbed.

It was based on the fact, known from transmitter design, that frequency-doubling does not introduce distortion in frequency-modulated waves. In fact the method is used in all transmitter circuits. In the present instance, the resultant I.F. FM carrier which has a greater deviation ratio, and a higher basic carrier frequency, is a true replica of the original.

Intermediate Frequency

The IF frequency (9.5 mc) was chosen to give the required bandwidth and IF rejection. As much stable gain as is possible is applied to the multiplier, which is designed to double efficiently at low-input levels, so that the IF band is transposed to twice its original frequency. Insofar as the FM spectrum is concerned, the original relationship of side frequency pairs to the carrier has not been disturbed, for both the deviation ratio and the new carrier frequency are doubled. This means that the discriminator offers no more of a problem than it would if the original spectrum were used on the lower IF frequency.

As shown in the block diagram, frequency doubling is accomplished in the 12SH7 first limiter-doubler stage (V106) following 3 IF stages at 9.5 mc, as shown in the schematic. Sufficient driving voltage is available at the grid of the doubler to cause it to draw grid current and act as a limiter. At the same time the circuit constants have been chosen to give maximum distortion and hence second harmonic generation. It is possible to obtain high gain ahead of the limiter, which is desired, without the additional limiter gain causing instability due to feedback, since the output frequency is double the IF input frequency, feedback is impossible and the plate load presents a low impedance load at the fundamental frequency.



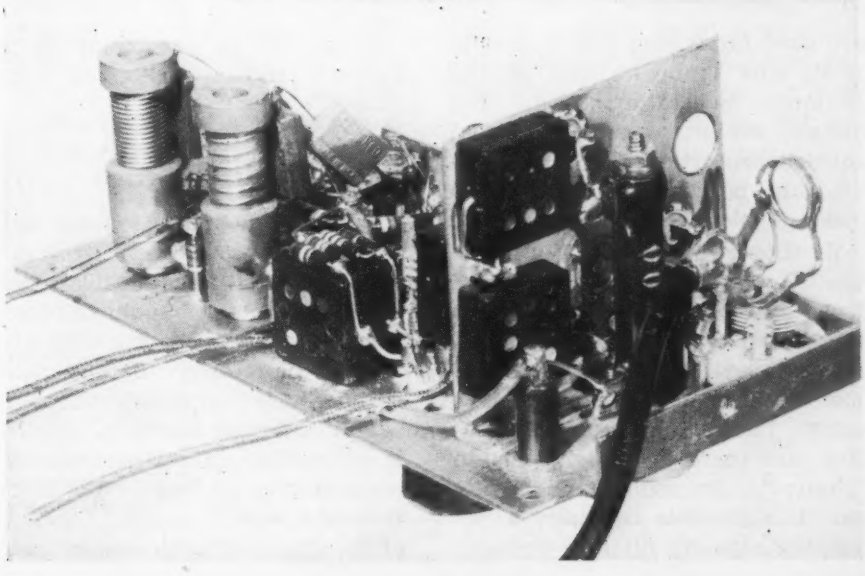
Greater noise immunity is provided by introducing frequency doubling in IF amplifier, which permits high enough gains for proper limiting without instability

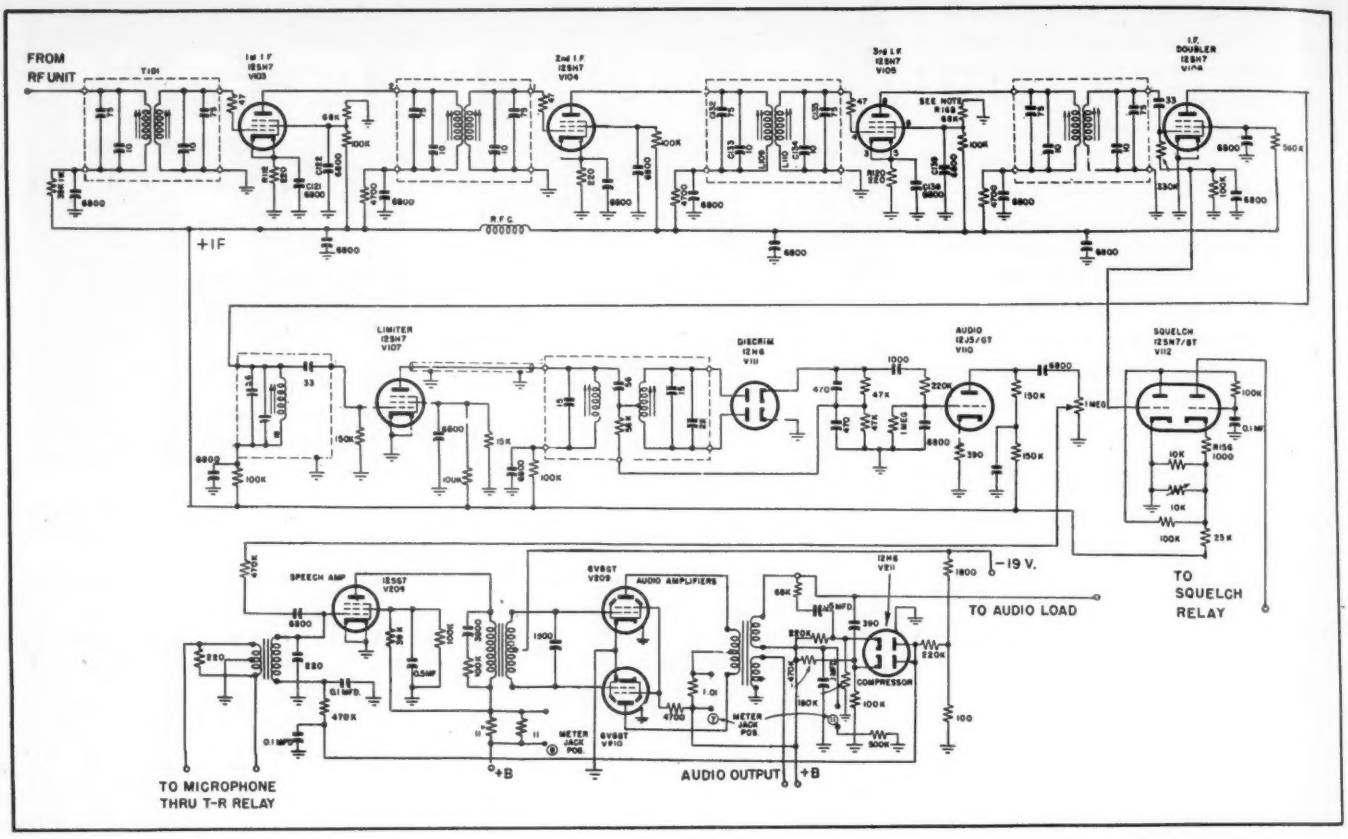
The IF sensitivity measured at the first IF grid is 50 microvolts for limiter saturation. A 0.75 volt input to the doubler-limiter is sufficient for complete saturation. When measuring at the grid of the first 12SH7 it will be found that the intermediate frequency is completely squelched in the absence of any input signal due to the square-law response of the doubler. When the overall gain is not sufficient to cause doubler action the circuit will exhibit no-signal squelch properties. A gain of approximately 100 is provided in the stages preceding the first IF giving theoretical saturation at about 0.5 microvolts input. In practice, first circuit and tube noises provide practically complete saturation in the absence of any signal.

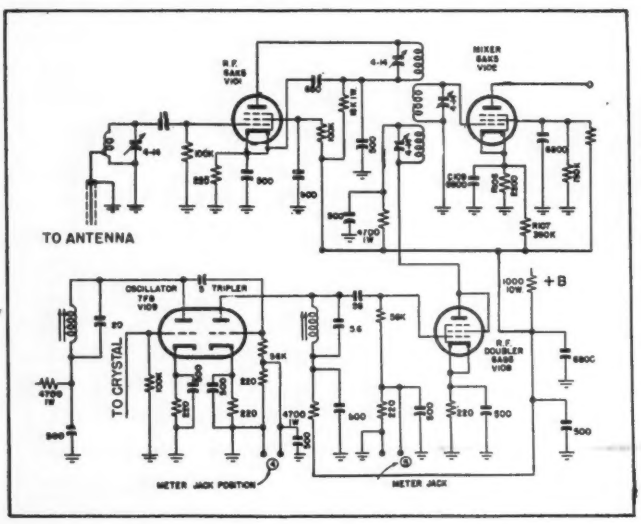
Removable Sub-assembly

As shown in the view of the rf subassembly this chassis contains the rf, mixer and harmonic generator stages. Making this unit removable allows for shorter leads and permits easy changing to any frequency outside the 152 to 162 mc band. Small variable capacitors

Photograph of the complete radio frequency sub-assembly for Bendix MRT-1B receiver







Above are essential circuits of the Bendix MRT-1B communications receiver, and at the left is the circuit diagram for the RF section which connects from the plate of the 6AK5 mixer tube to the IF and audio section.

are used for tuning the rf circuits while slug tuning is used in the harmonic generator string. The circuit exhibits useful no-signal squelch properties when the over-all gain is not great enough to cause doubler action.

As shown in the circuit diagram the squelch system is operated from the voltage developed across the second limiter grid resistor. A dc amplifier (12SN7) is used to allow operation of a telephone type relay. The relay operation is positive and there is no tendency to "chatter". By using a dc amplifier it is possible to insert a resistance-capacity filter in the second section of the amplifier to prevent relay operation on noise pulses.

Relay Operated Squelch

Relay-operated squelch has certain advantages over electronic squelch. First, it is possible to remove B+ from the audio amplifier, thereby reducing the stand-by current of the receiver. Second, there is no "knee" to worry about in which distortion is severe. Finally, it is possible to actuate external alarm devices such as bells or lights from the squelch system. Because of the extremely high over-all gain, reliable squelch operation is possible on a small fraction of a microvolt, even below limiting.

The IF string consists of three cascaded gain stages using 12SH7 tubes. These are used in preference to 6AC7's because sufficient and more consistent gain can be attained with the 12SH7's. Three stages are needed to give the desired pass band characteristics. All IF transformers are permeability tuned and temperature compensated so that the maximum IF drift from — 50° C to + 80° C is + 6 to — 2 kc. To further reduce drift, the crystals are AT cut units, ground to an accuracy of 0.005% and held in a temperature controlled oven at 70° C.

The doubler circuit has resulted in an FM set having extreme sensitivity with excellent stability. The intermediate frequency in the practical receiver doubles back on itself without introducing any instability. In addition, the problem of spurious responses present in the double superheterodyne has been eliminated, and the simplicity of the single superheterodyne has been retained. Field tests have indicated that a most satisfactory receiver can be easily provided for the emergency services using this circuit.

High Efficiency Loud Speaker

15-watt unit developed for rigorous Navy conditions requiring operation after submersion and construction capable of withstanding gun salvos

• A great many problems difficult of solution were involved in the development of loudspeaker equipment suitable for the rigorous conditions met in shipboard installations and Navy specifications set standards perhaps higher than ever set before. Consequently interest attaches to a 15-watt unit developed by University Loudspeakers, Inc., New York, which gave a performance of this high order:

(1) The diaphragm is capable of withstanding the concussion of 16-in. broadside gunfire and the pressure of exploding shells within a reasonable distance; (2) A high articulation factor, makes it readily intelligible while operating in the vicinity of battle noises; (3) Ability to operate normally immediately after submersion in salt water; (4) Uniformity of sound distribution in every direction, providing 360° coverage when suitably installed; (5) Ability to withstand the effects of corrosion, salt, spray, humidity, high and low temperature, or fungus, and to prevent the entrance of seaweed and microscopic sea organisms.

The loudspeaker may be submerged to a depth of 200 ft. without injury to the diaphragm. A very simple construction feature makes this possible. Below the phenolic diaphragm is a dome, shaped to the contour of the diaphragm and separated from it by .070 in. Under the pressure of water at great depth, the diaphragm undergoes a normal movement of .070 in. and then it is supported by the heavy restraining dome, which prevents its destruction.

This design feature also permits the diaphragm to withstand the concussion of gun blast and exploding shells. Under a wave of compression the diaphragm is forced back against the restraining dome below it. During the recession wave or rarefraction, the diaphragm is sucked outward until it meets a bowl-shaped recess in the housing. The diaphragm thus has a free motion of plus or minus .070 in.,

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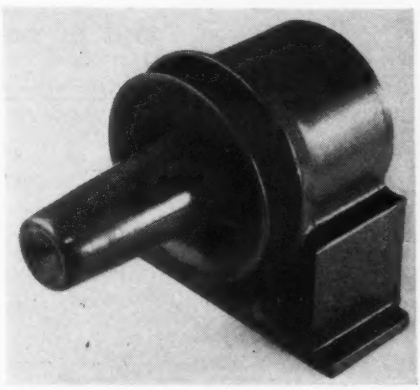
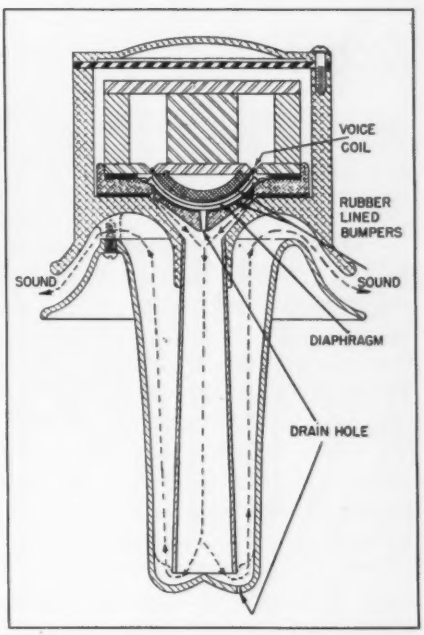
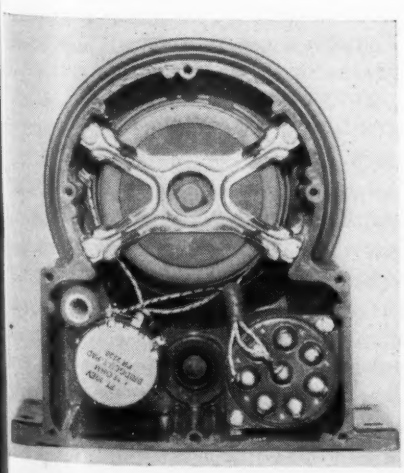


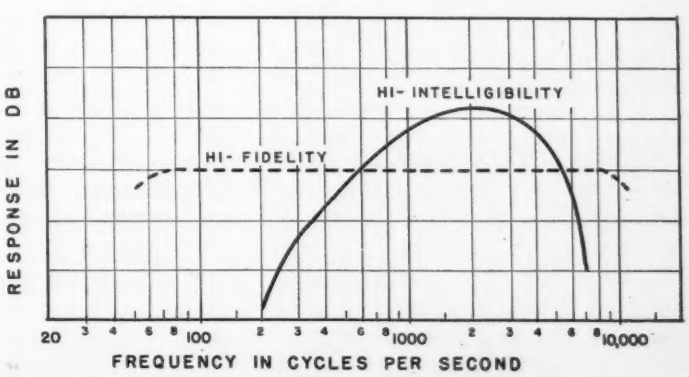
Nicknamed "Buck Rogers," horn length of 8 in. actually provides air column of 17 in.; whole unit completely sealed.

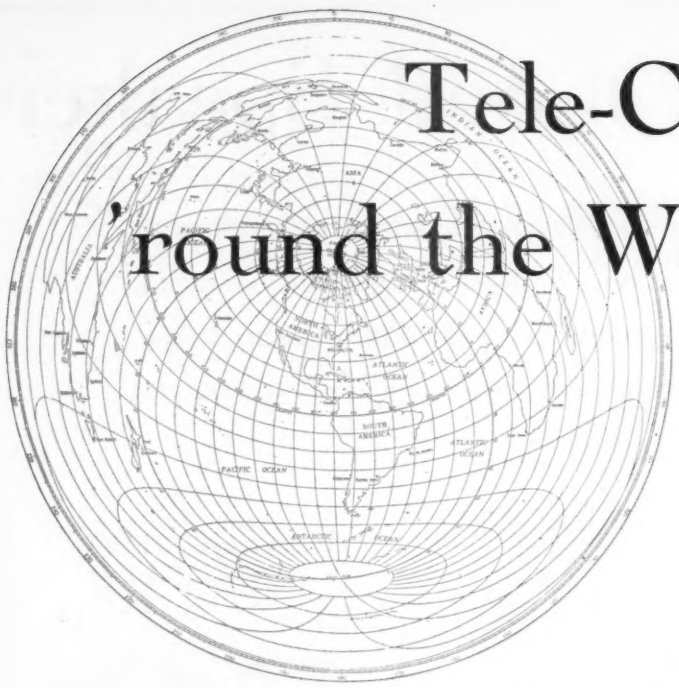


Cross section of complete unit showing construction and sealing method



Back of driver unit, sealed with clamping cover, showing attenuator and transformer. Curve shows comparison between high fidelity (dotted line) and peaked response, latter affording increased articulation and greater apparent loudness





Tele-Communications 'round the World

By ROLAND B. DAVIES,
Tele-Tech Washington Bureau

News of engineering matters of importance and of markets in various foreign fields

BATTLE FOR FOREIGN MARKETS UNDER WAY—The battle for foreign export markets has already commenced in a formidable manner between the leading British and Dutch manufacturers and the American manufacturers, particularly in Latin America. The Electric & Musical Industries Ltd., leading British radio manufacturer, through its managing director, Sir Ernest Fisk, recently disclosed that since the end of the war it has re-established its extensive interests in manufacturing and selling in Argentina, Australia, Brazil, Chile, China, Czechoslovakia, France, Greece, India, Italy, New Zealand, Spain and Turkey. Sir Ernest stated that "as time goes on" his company hopes to assist "the national economy" by extending further the range and quantity of its exported products, including transmitting and receiving apparatus and industrial electronic equipment. EMI has made arrangements to manufacture and supply the entire British Commonwealth with the latest types of FM radio transmitting equipment and a complete system of *electronic television*.

STIFF COMPETITION IN BRAZIL—American radio manufacturing companies such as RCA Victor, International Standard Electric, etc., have been facing stiff competition in Brazil from British Marconi and Philips (Netherlands) recently in connection with installation of new broadcasting stations. Marconi received the contract for supplying transmitters for the new broadcast (long-wave and short-wave) stations at Bahia and Recife, both 20 kw. Bahia will eventually go to 50 kw. The Bahia station is part of the 13-station network owned by Assis Chateaubriand and the Recife station is owned by the newspaper *O Jornal do Comercio*. On tubes these two companies are reported to have the jump on the U. S. manufacturers—Marconi delivering tubes on a 30- to 60-day basis even during the war and Philips following the invasion of the East Indies diverted tubes, originally intended for the Far East, to Argentina and Brazil.

BRITISH LICENSING AGREEMENTS—Electric & Musical Industries, Ltd., of Great Britain has revealed two patent and development licensing arrangements which promised to implement the progress of FM broadcasting throughout the British Empire to a major degree. One was an arrangement with Major Edwin Armstrong, inventor and pioneer of the FM system for broadcasting and radio-communications under which the EMI parent and subsidiaries companies can manufacture and supply both transmitting and receiving apparatus under Armstrong patents and also have the right to issue sub-licenses under the patents. EMI also has secured the latest designs and manufacturing techniques from Radio Engineering Laboratories, a leading U. S. manufacturing company which produces FM transmitting apparatus for the Armstrong system.

EXPORT FIGURES TELL—Story of progress of British exports of receiving sets and tubes since the end of the war are graphically depicted in recent Commerce Department figures. For the nine months ending Sept. 30, 1946 there were exported 207,738 receiving sets, valued at £1,939,304 which compares with 8,187 receivers, valued at £95,795 for the 1945 three quarters, and 63,480 receivers, valued at £330,798 in 1938. During the 1946 three quarters, there were 3,329,545 tubes with a value of £1,019,652. The 1945 period recorded 1,249,714 tubes with £592,848 value and the 1938 period 1,654,437 tubes and £371,454 value. Re-exports of imported equipment was not included.

TELEVISION IN GREAT BRITAIN—The British Broadcasting Corp. and the leading English manufacturers, notably E.M.I. Ltd., are claiming great accomplishments in television, asserting the British video service is "equal to the best in the world." Television receivers also are being sold in England at prices lower than in the United States. Sir Ernest Fisk, E.M.I. Managing Director, had some recent interesting comments on

black-and-white versus color television with a view that very high definition or color television cannot be expected "in practice at an early date." He said that, while it is known how to produce the studio and pick-up equipment for color video, there are some "ancillary technical problems" to be overcome which "require a number of years, further research and exploration."

RADIO-ELECTRONICS EXPOSITION IN PERU NEXT JULY—American radio-electronic manufacturers have been invited by the Peruvian Government to participate in a Radio-Electronics Exposition to be held in Lima, beginning July 15, 1947. Contracts for floor space have been mailed by the government to manufacturers from all countries of the world. All foreign equipment for the exhibition will be allowed to enter Peru duty-free, the government has ruled.

GUATEMALAN BROADCASTING STATIONS—The Guatemalan government recently issued regulations for programs and commercial announcements for all broadcasting stations in the country. The Ministry of Communications and Public Works was designated in the government's executive decrees as the agency to enforce the new regulations. The stations were directed to dedicate the most possible time to cultural programs and, where dual transmission facilities exist, to use the entire time of a single transmitter for such purposes. The Guatemalan government's rules on the time of commercial announcements allow much greater advertising time—two minutes on a five minute program, 4½ minutes on a 15-minute program, 15 minutes on an hour program—than United States stations do on a voluntary basis.

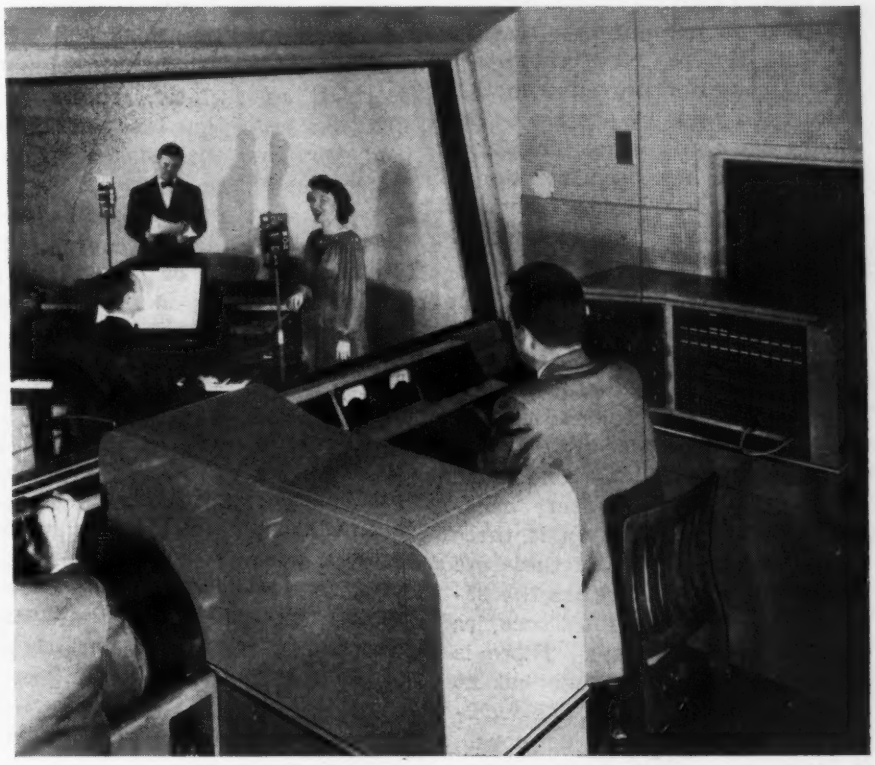
ARGENTINA TO INCREASE NUMBER OF RADIO COMMUNICATIONS STATIONS—As result of the government's acquisition of the I. T. & T. wire telephone company, the Telecommunications Department of the Argentine Post Office is planning an expansion of domestic radiotelephone and radiotelegraph stations, which promises to be a market for American manufacturers for that type of equipment. Extension of radiotelegraph facilities for expansion of communications in and with Patagonia is major project.

CZECHOSLOVAKIA PLANS RADIO PRODUCTION IN WAR RECOVERY—The law recently acted upon by the Czechoslovakian National Assembly, calling for a two-year plan of industrial recovery from the ravages of the war, contains in its program the production of 150,000 home radio receivers each year in Czech factories for 1947 and 1948. This is significant in that it demonstrates the Czech government will want purchase of "home" products first before imported sets from the U. S. A. or any other country.

RADIO RECEIVER PRODUCTION IN GREAT BRITAIN AT ALL-TIME HIGH—Production target in United Kingdom for new home radio receiving sets for the year from June, 1946, to May, 1947,

(*Continued on page* 124)

New Studio Control Equipment for WOR



Three WOR-Mutual studios in New York are now newly equipped with special studio control booth equipment manufactured by Western Electric. Each console provides facilities for inputs from 16 microphones, two transcription reproducers, eight incoming remote lines and six program trunks. The equipment features compact construction, plug-in units, and flexibility. It is designed for high fidelity and low noise levels and can be used to serve both AM and FM radio broadcast transmitters and networks.

Talk back facilities between the control booths and studios enables conversations to be carried on right up to program time. Special faders, reverberation amplifiers, echo chambers, and sound effects filters are incorporated in the design to obtain desired dramatic effects with a minimum of personnel.

The use of transparent dials on fader knobs, another recent innovation in broadcast circles, is used on the WOR equipment. These dials are friction mounted and can be rotated independently, thus enabling the monitoring operator to present the volume setting of a number of different faders without the necessity of remembering each marking. The operator can then turn up the volume of any microphone to the predetermined setting without overshooting the setting.

Thomascolor for Television

Originally developed for providing color motion pictures with black and white film, system is adaptable for use with simultaneous color TV

• More than 16 years of development work by Richard Thomas in the field of colored motion pictures and still photography has resulted in the system now known as Thomascolor for providing motion pictures in color by the use of ordinary black and white film. Since the method has been mentioned for simultaneous color television systems, a review of his method may be of interest.

At the camera end the light from the scene passes into a special lens where first it is split by prisms into three rays. Each ray passes through its own lens and a color filter, red, green and blue respectively. The three rays then fall upon one frame of standard motion picture negative film, recording upon it three discrete images. Two of these are placed side by side within the 35-mm. frame and the third occupies a position below these. There is space for a fourth image but at present this is not used. The density of each image, when developed, depends upon the intensity of the light passing through the color filter associated with that image. Positive prints from such a negative would be made on ordinary black-white stock. There is no color associated with the film.

Upon projection, three images per frame are available and each of these, after passing through its correct color filter, enters the Thomas projection lens which not only projects the images on the screen in the usual manner, but provides three mechanical adjustments which allow the three projected images to be superimposed accurately, giving motion pictures in natural colors.

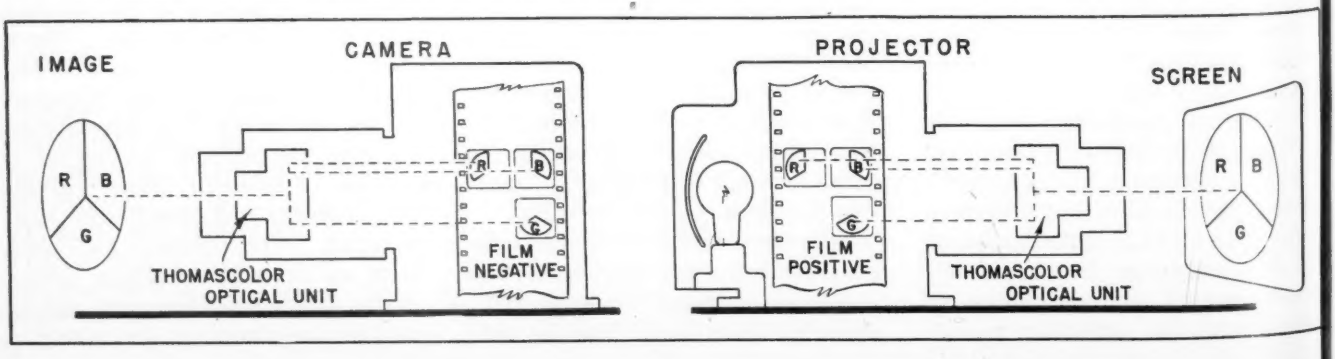
Speedy Process

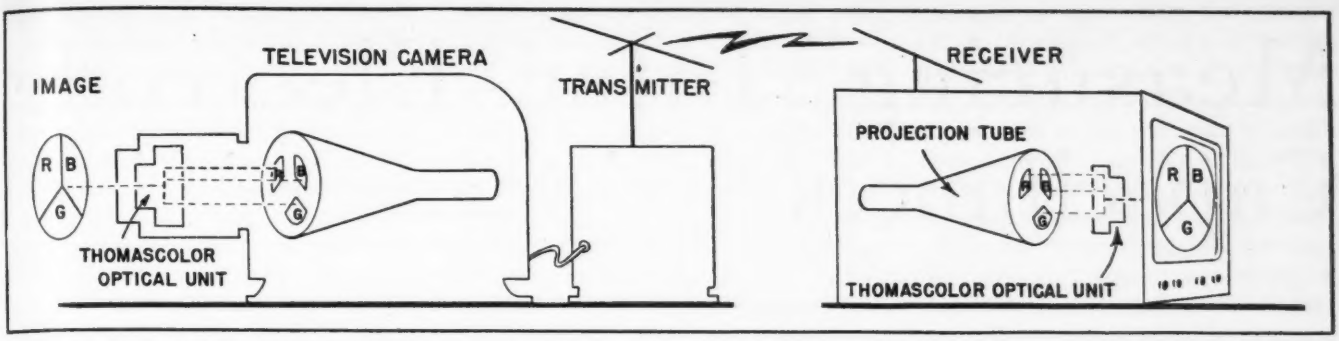
Pictures of good color fidelity thus are made available with unusual speed and economy. The entire process from exposure to projection can be done in 45 minutes, compared with days for the subtractive, dye-colored films. The film and processing costs are those of low-cost black-white film.

The system is classified as an additive, simultaneous system. It is claimed that since the light is passed through a single aperture there is no parallel problem. Regarding resolution, it was stated at the FCC hearing on Color TV Standards by Carl Haverlin, vice-president of Thomascolor, (also vice-president of Mutual Broadcasting System): "It appears that in the present low band (black-white TV), dividing a picture into three separate images will reduce the mathematical definition by 50 per cent. However, based upon our experience with motion pictures, where a 35-mm. frame is divided into three images and recombined on the the screen, we are certain that no loss of apparent definition will result."

There have been several showings of motion pictures using the Thomascolor system, but the portable equipment which Haverlin had with him on his visit to Washington consisted of a 300-watt projector for still pictures. Strips of positive 35 mm. film bore the characteristic three-image-per-frame pictures taken by a Thomascolor equipped camera. The portion of this projector that contained the filters and optics designed by Thomas was about 6 in. long and 6 in. in diameter. This cylinder contained the three projection lenses and the three controls. The control which was used

Schematic arrangement of two units utilized in the Thomascolor system for the production of color from black and white





Arrangement of similar Thomascolor components showing manner in which the equipment might be used for color television

to bring the three images into register was not at all critical in adjustment. The type of demonstration material provided showed convincingly the fidelity of the colors and gave the observer an idea of the quality of the reproduced picture.

Resolution Losses

With the limited equipment, designed for another purpose it was not possible to determine experimentally how much resolution was lost, at least not in a quantitative manner. The question to be answered is: Compared with the usual black-white 35-mm. system used for movies, how much resolution is lost by using three images of the scene to be shown, when each image on the film is reduced to about 16 mm. in width and is projected through a lens of reduced aperture, and the three images are finally superimposed to form one picture?

It is agreed by motion picture-television engineers that 35-mm. film projected in the theatre represents about 1080 lines and 16-mm. film corresponds to a television picture of about 510 lines. But what happens when three 16-mm. images are superimposed? We know that the light intensity increases. Does the resolution increase?

For television the simplest arrangement would be to project into the standard black-white TV film scanner a Thomascolor film. On the black-white receiving tube would appear the three images. These might be projected, superimposed, on a screen after passing through three filters specially selected to work with the cathode ray tube used. It is believed this would produce pictures in color but such a simple system probably would suffer from low resolution and lack of flexibility.

Thomascolor, Inc. suggests using the special lens system placed in front of the camera tube in a simultaneous TV system and in front of a single (not a 3-unit) projection tube at the receiver. This means, of course, that the tubes just mentioned, instead of carrying a single large picture, will have impressed three smaller pictures, each of which will bear less than one-third of the picture "information" contained in a single normal picture.

Another application may be the Thomas type of lens, prism and filter unit with the camera of a simultaneous TV system that utilizes a three-unit projection tube at the receiver.

When color television broadcasting "arrives" it is possible that the only source of color film showing current events, news, etc., may be that obtained through Thomascolor because of the speed with which it can be processed.

Television Comes To New York Hotels

The Pennsylvania Hotel is the first in the New York Metropolitan area, if not the first anywhere, to serve its patrons with television programs. A total of 18 table model sets have already been installed and plans are under way to increase the number of installations as the demand grows. The sets are by RCA (630-TS) and have a 52 sq. in. direct view screen.

Sets are installed in twelve of the spacious studio type rooms from the twelfth to the seventeenth floors. The Pennsylvania cocktail lounge is furnished with four sets and two private dining rooms have one apiece. From the business side, it is reported that the television feature has attracted many to the cocktail lounge.

The Hotel Pennsylvania is conveniently located so that three dipole antennas with directors are oriented in one general direction and satisfactorily receive signals from three New York television transmitters. Each antenna of the type mounted on the Pennsylvania roof is limited to serving six television sets. A specially designed transmission line for home television receivers, manufactured by RCA, is used. The line is designed to have a characteristic impedance of 300 ohms.

The Statler Hotel Co., which owns the Pennsylvania, had hoped to install television sets in the new Statler in Washington, D. C., but television equipment was not generally available at that time. However, ground will be broken for a new Statler Hotel in Los Angeles in the early part of 1947 and it is planned that the architectural design will include facilities for television installation.

The Hotel New Yorker is now nearing completion of a television installation comprising seven television sets, although the plans will be flexible enough to allow for additional installations as needed. The New Yorker television equipment is also of the RCA 630-TS table model type and will use the RCA television receiver transmission cable throughout. At each television receiver outlet, a switch equipped terminal box will allow a 300 ohm resistor to be bridged across the transmission line to terminate in its characteristic impedance when the receiver is in the repair room.

Measuring Inter-Electrode Capacitances

By C. H. YOUNG, Bell Telephone Laboratories, New York

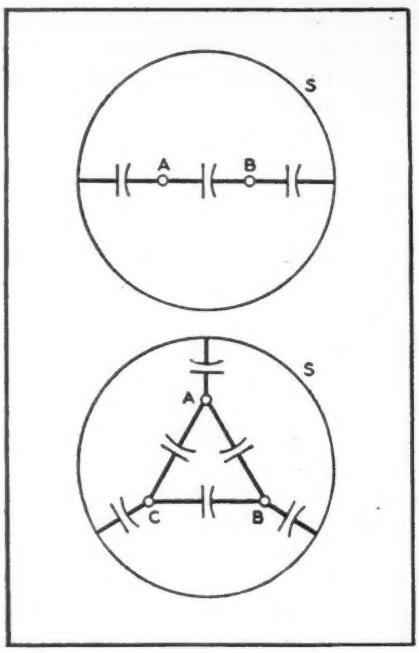
New bridge, developed for measurement of extremely small values in high frequency tubes, useful to two-billionths of a microfarad

● Following the trend in the communication art toward the use of higher frequencies it often becomes desirable to measure extremely small values of capacitance.

In the development of high-frequency electron tubes the direct capacitance between the grid and plate of such a tube may be very important to the operation of the circuit, and yet it may be as small as two billionths of a microfarad. No standard capacitors of this order of magnitude are available with which the unknown could be compared in the ordinary type of bridge. Moreover, the residual capacitances in the bridge and the effects of the capacitances of the test leads make the technics for larger capacitances entirely impracticable.

A further difficulty enters because the capacitance of importance is the "direct" capacitance, and the measurement must thus exclude capacitances from the two elements to other elements and ground. Suppose, for example, that it was desired to measure the direct capacitance between elements A and B in the structure shown at the top in Fig. 1. By the earliest methods this would be done by first grounding A while leaving B ungrounded and then making a measurement between A and B. Following this, A would be left ungrounded and B would be grounded and a similar measurement made. A and B would then be connected and a third measurement made to ground. From these three measurements, the direct capacitance between A and B could be determined.

Fig. 1—With two conductors in a grounded enclosure, there are three capacitances involved; with three conductors there are 6 capacitances



Where more than three elements are involved, as at the bottom in Fig. 1, many more capacitances may be involved, but by grounding all elements but one it is always possible to determine a direct capacitance from three grounded measurements.

In many present-day applications these additional capacitances are so much greater than the direct capacitance being measured that dependable data can be secured only under the most carefully controlled laboratory conditions.

The main objectives are to measure very small direct capacitances by means of capacitances of larger sizes, and to eliminate the effects of the capacitances to ground and of the leads. Since any physical capacitance has a conductance closely associated with it, such as the leakage through the insulating material, a capacitance is more correctly referred to as an admittance where precise measurements are concerned. For these investigations a new form of admittance bridge has been invented, which measures the capacitance and conductance components separately. Omitting its power supply, detector, and shielding, this new bridge can be

represented as is shown in Fig. 2.

The conventional form of bridge would have an adjustable admittance connected in the AD arm and the unknown admittance would be connected in the CD arm as shown in Fig. 3A. A variant of this might have adjustable admittances in both the AD and CD arms arranged so that when one of them was decreased, the other would be increased. The unknown admittance would then also be connected across the CD arm, and its value could be determined from the settings of the two adjustable admittances after balance had been secured. The circuit of Fig. 2 is the equivalent of this latter arrangement, and at the same time secures certain other advantages.

Delta Equivalents

Any three-terminal star network such as g_A, g_C, and g_E of Fig. 2 can be replaced by an equivalent delta network. If this were done for the star conductance group of Fig. 2, the circuit would become as shown in Fig. 3B where G_{AC}, G_A, and G_C are the delta equivalents of the star conductances of Fig. 2.

Since G_{AC} is connected across the diagonal of the bridge it has no effect on the measurement and may be disregarded. There thus remains a star connected network of admittances between points A, C, and D. This also could be replaced by an equivalent delta consisting of Y_{AC}, Y_{AD}, and Y_{CD} as shown at Fig. 3C. Here, Y_{AC}, since it is across a diagonal of the bridge, has no effect and can be disregarded as is G_{AC}.

This leaves Y_{AD} and Y_{CD}, and thus an unknown admittance connected across CD could be measured by adjusting Y_{AD} and Y_{CD} differentially—changing them simultaneously in opposite directions while keeping their sum constant. The unknown admittance Y_U would then be equal to Y_{AD}—Y_{CD}. The equivalent admittances Y_{AD} and Y_{CD} may be expressed in terms of g_A, g_C, C_A, and C_C of the original configuration, and proper adjustment of these elements would permit the unknown admittance to be evaluated. There is a very important advantage arising from the use of the double star network (Fig. 2).

In adjusting the conductances and capacitances of the original configuration, the sum of g_A and g_C is always kept constant as is that of C_A and C_C. As a result, the sum of the two admittances Y_A and Y_C of Fig. 3B, is also constant and has a constant phase angle. If the phase angle of Y_D is made equal to this constant phase angle, it can be shown that the unknown admittance is equal to a constant times (Y_A—Y_C), and that this constant will vary with the value of Y_D. It can also be shown that the capacitance component of the unknown is equal to this same constant times (C_A—C_C), and that the conductance component of the unknown is equal to another constant times (g_A—g_C). In both cases, the value of this constant is less than unity.

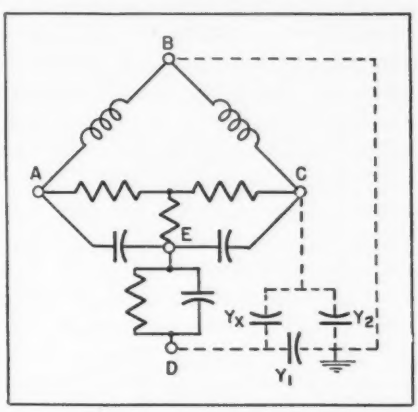


Fig. 2—The direct capacitance being measured is treated as a three-terminal network and connected as diagrammed

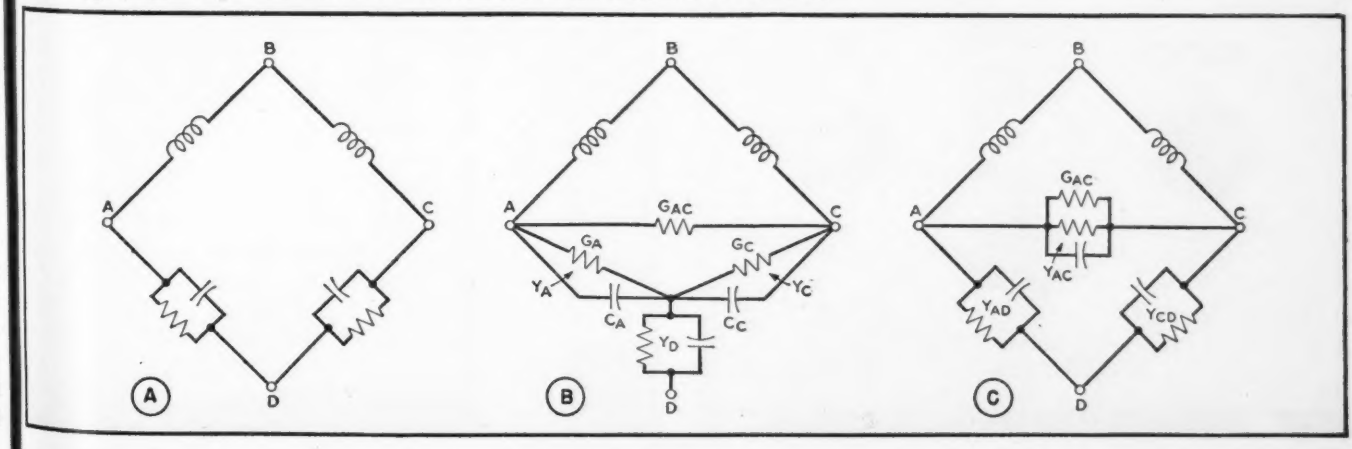
The double-star network of conductance and capacitance of Fig. 2 thus not only enables the conductance and capacitance of components to be measured by differential adjustments of g_A and g_C and C_A and C_C, but provides an adjustable multiplying constant in the equation so that the actual values of the standards may be much larger than the corresponding components of the unknown.

Adjustable Range

In the actual bridge, the conductance and capacitance standards are adjusted so that five constants are available in consecutive decimal steps of 1, 0.1, 0.01, 0.001, and 0.0001 which for convenience are indicated as reciprocals which are used as divisors. The adjustable range of the quantity (G_A—G_C) has a maximum value of 10 micromhos, readable to 0.5 micromho, and (C_A—C_C) has a maximum value of 110 mmfd adjustable to 0.1 mmfd. Using the divisor of 10,000, therefore, the capacitance of the unknown can be read to a hundred-thousandth of a micro-microfarad, and the conductance to five hundred-thousandths of a micromho.

Direct capacitance measurements are accomplished by treating the unknown as a three-terminal network. In measuring plate to grid capacitance of a vacuum tube, for example, all the tube elements ex-

Fig. 3—By changing the star network of conductances of Fig. 2 to a delta, the bridge would become as at B below. Then by changing the star mesh of admittances of the latter diagram to a delta, the circuit would become as shown at C. This makes the bridge effectively the same as the conventional form shown at A at the left



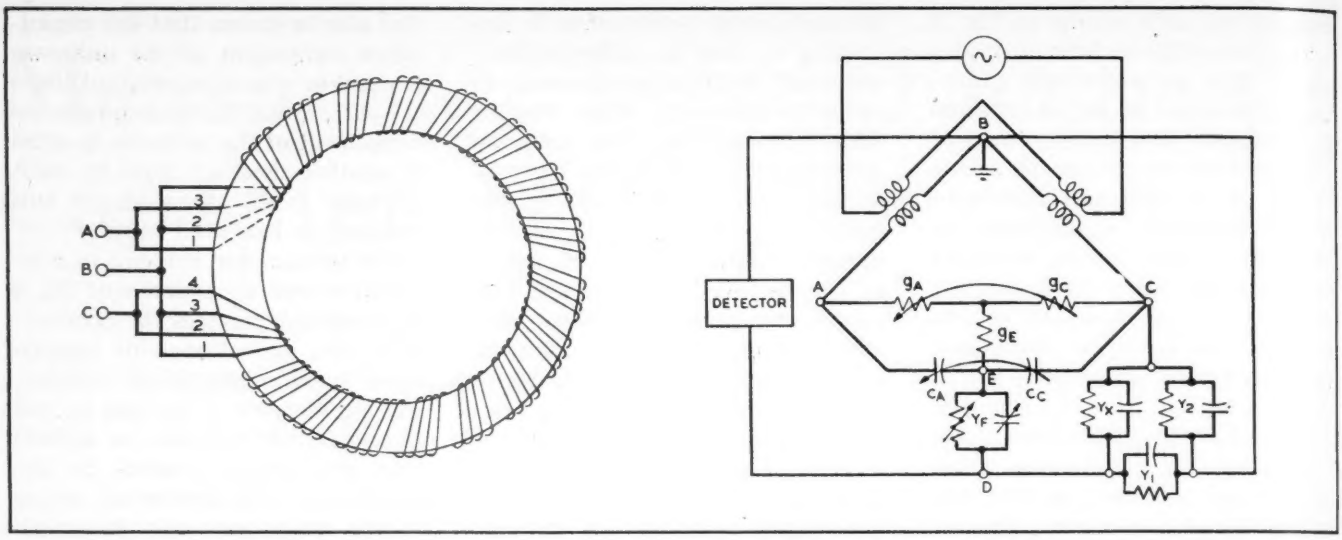


Fig. 4—Method of winding ratio arms in capacitance bridge **Fig. 6—The bridge circuit and the unknown, less shielding**

cept the plate and grid are connected together and to ground, and the leads from the plate, the grid, and ground will be brought to the bridge.

These three leads embrace three admittances: the direct admittance between grid and plate; the admittance from the grid to the other elements and ground; and the admittance from the plate to the other elements and ground. Since ground is one of the terminals for both of these latter admittances, the three admittances are actually arranged in a delta network, which is connected to the bridge as shown by dotted line connections in Fig. 2, where Y_X is the direct admittance between plate and grid, Y_1 the admittance between grid and ground, and Y_2 that between plate and ground. The bridge is provided with two coaxial jacks, and the plate and grid would be connected to the inner conductors of the two coaxials while the ground leads to which all the other elements of the vacuum tube are connected would be connected to the two outer conductors of the coaxial.

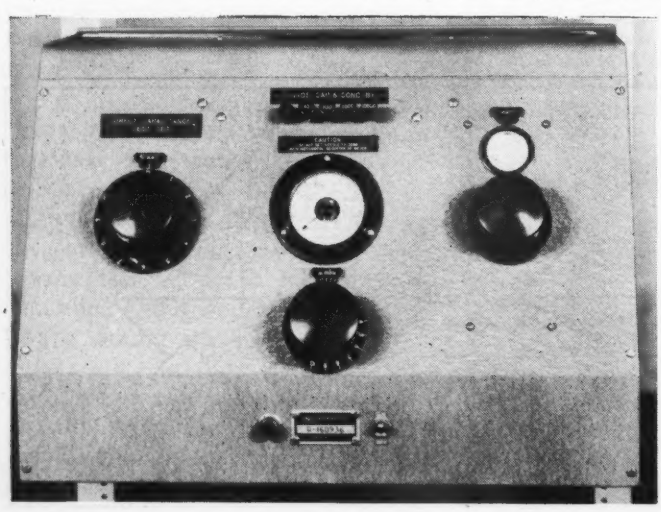
With the connections so made, Y_X is across the CD corners of the bridge and is thus in the position for measurement. Y_1 is across the diagonal of the bridge and thus has no effect on the measurement, and is effectively eliminated from consideration. Y_2, however, is effectively in shunt with the BC arm of the bridge, and with the more usual type of bridge would definitely affect the bridge reading. In this new bridge, however, its effect is eliminated by the design of the ratio arms AB and BC.

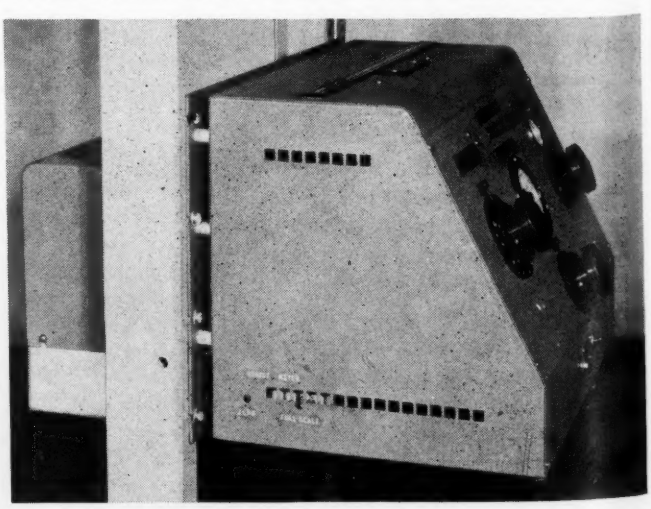
These two arms, which are identical, consist of the secondary winding of a transformer, the primary of which is connected across the ac power supply. These two ratio arms are formed by winding four parallel wires on a torroidal core and then connecting them as indicated in Fig. 4. Alternate parallel wires are used for each half of the winding to reduce leakage inductance.

Over this secondary with suitable electrostatic screening is then placed the primary winding. Because of the very close coupling between the wires of the secondary forming the two arms of the bridge, any voltage connected into one arm or any admittance connected across it would be directly reflected into the other as an equal voltage or admittance. The admittance Y_2 connected across BC is therefore reflected as an equal admittance across AB. It will thus have the same effect as an admittance connected across AC, and will not affect the reading of the bridge. Thus both Y_1 and Y_2 are made to have negligible effect on the reading of

(*Continued on page* 109)

Fig. 5—Side and front views of the bridge showing oscillator and rectifier power supply mounted behind bridge and detector





Precision Master Oscillators

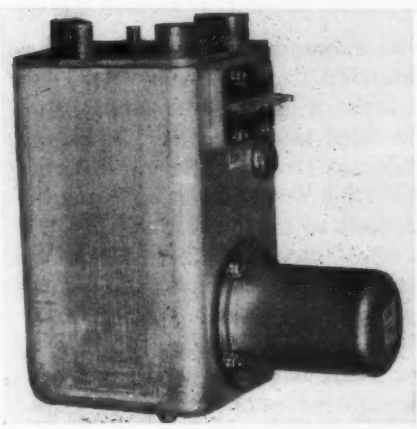
By T. A. HUNTER, Project Engineer
Collins Radio Co., Cedar Rapids, Ia.

Permeability tuning, sealing and meticulous care in both design and construction give stability equivalent to crystal control

• The stability of variable frequency oscillators is influenced by a factor which heretofore has been overlooked by many engineers: humidity. The very serious effects of humidity and the lack of understanding of this problem have undoubtedly delayed the development of the stable master oscillator. The dielectric constant of moist air is greater than that of dry air which means that a humidity change is primarily reflected as a capacity change in an oscillator circuit. The presence of moist air and actual condensation of water on the coil, the tuning condenser and other components, results in a frequency shift as compared with the dry air condition. As may readily be seen, the condenser tuned oscillator is a more serious offender in this respect, because the plates of the tuning capacitor are exposed to the air.

In a permeability-tuned oscillator the tank capacitor may be a sealed unit which eliminates this one large cause of frequency instability; however, frequency changes due to the effects of humidity on the coil form are still present. As an average figure obtained from a series of experiments, one can expect about one-tenth the frequency deviation with humidity using a permeability tuned oscillator as compared with a capacitor-tuned variety.

In laboratory tests humidity often tends to cover up the effects of temperature variation. In a typical test setup, an oscillator was placed in a heat chamber and operated through the temperature range of $-10°C$, to $+50°C$. Each time the oscillator would stabilize at these temperatures, the resultant frequency was decreased by some 50 to 100 parts per million for each excursion. If the oscillator was allowed to remain at room temperature, for ten to twenty hours, the frequency would drift back to its starting value. This slow drift back to the starting frequency was undoubtedly due to the gradual loss of moisture from the components of the oscillator.



External appearance of the oscillator, which is permeability tuned and sealed

The obvious solution to the humidity problem is to operate the oscillator in a controlled atmosphere. This would be equally effective for either the capacitor or the permeability tuned oscillator.

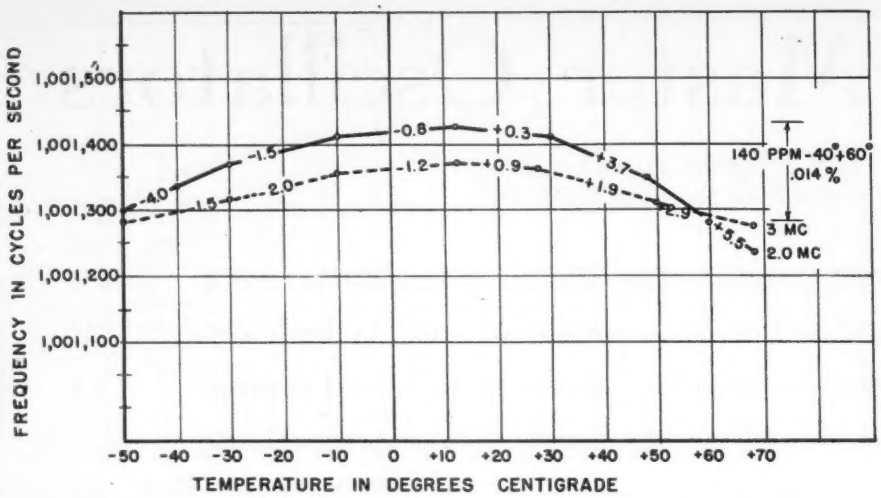
Sealed Chamber

As an approach to the controlled atmosphere, a sealed chamber was devised with all joints and bearings treated to prevent leakage. In the final form, the entire oscillator including the tube, is enclosed within a pressurized container. Aluminum castings proved to be very porous and could not be used, but drawn aluminum cans are entirely satisfactory for the oscillator housing.

When the oscillator is placed within the pressurized chamber and passed through temperature cycles, excellent results are obtained. It is only under this condition that it is possible to repeat temperature-frequency measurements. With a properly sealed oscillator, it is possible to submerge the unit in water for a week without having the frequency deviate more than 10 to 15 parts per million over the entire

EARLY tuning of oscillators, as in other circuits, was by means of inductive variation with a fixed tuning capacitor. However, as suitable variable capacitors were developed, the shift was almost universally toward capacitive tuning of the oscillator. The development of an iron core suitable for use at radio frequencies, again made inductive tuning possible.

In recent years, many new frequency bands were added to the usable radio frequency spectrum, making it necessary to use either a large number of crystals or a master oscillator possessing a stability equivalent to that of a crystal controlled oscillator. This paper points out the advantages of choosing a permeability tuned oscillator where high stability is a requisite.



Typical temperature-frequency curve for a 2-3 mc oscillator coil. The change is in parts per million in frequency—more easily measured than inductance increments

period of the test. By including a small amount of some desiccating agent such as silica gel, any moisture that is sealed into the oscillator or subsequently enters is taken up and does not affect the stability.

There are many elements in an oscillator which contribute to frequency instability. To a large degree, these are all connected with the coefficient of expansion which shifts the position of the constituent parts of the tuned circuit. An additional variable is introduced by the change in frequency according to the relation, $F = -\frac{1}{2\pi}\sqrt{\frac{1}{\epsilon} - \frac{R^2}{4L^2}}$. Another possible cause of inductance change with temperature is the shift of the equivalent current sheet thickness as the resistance changes.

In both the permeability tuned and the capacitor tuned oscillators variations in the diameter of the coil form, shifting of the position of the wire of the coil and the change in the overall length of the oscillator coil all contribute to frequency instability. When isolating the various frequency effects of a variable temperature in an oscillator, it is necessary to consider all the parts of the tuned circuit, even including coil supports, terminals and method of wiring.

The most difficult problem at present is that of finding coil forms which are uniform and controllable in their temperature coefficient characteristic.

With an oscillator which is sealed against moisture, more latitude is permitted in the selection of a material which will produce a coil with a temperature coefficient characteristic which will tend to straighten out the non-linearity of the fixed tank capacitor. By this it is meant that certain more porous materials might be used which, if exposed to the atmosphere as in a normal oscillator, might become saturated with moisture and be unusable.

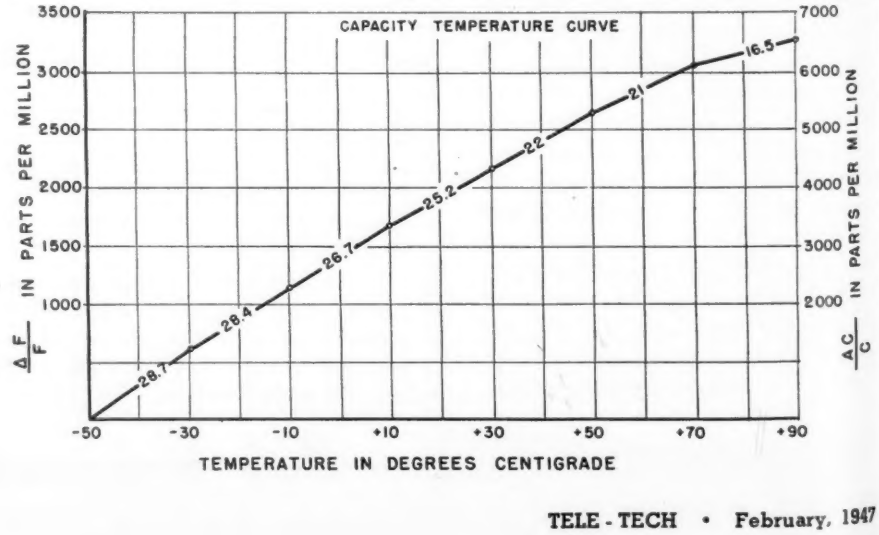
Overall temperature deviations of less than .02% are possible in production for temperature ranges of 100°C. A typical curve is shown for a 2 to 3 mc oscillator. It may be observed that the frequency deviation is less at the high frequency end of the band than at the low frequency end which is a desirable feature since it tends to produce a uniform frequency deviation due to temperature across the tuning range of the oscillator.

A permeability tuned oscillator is less susceptible to vibration modulation, as is evident when one considers the mechanical instability of the average capacitor rotor plate assembly. In the permeability tuned oscillator the tank capacitor is fixed and is completely insensitive to vibration effects. If rigid leads with good mechanical support are used in wiring the tuned circuit of the oscillator, capacity variations due to vibrations are practically eliminated. There remains only the inductance variation due to changes in the relation between the core and its coil. Since the iron core is ordinarily a light compact mass, the frequency variation is rather limited. By selecting thick capacitor plates, wide spacing between the plates, and "electrical" centering of the rotor it is possible to secure satisfactory results by means of capacity tuning. A very rugged frame may be used to eliminate capacitive variation due to the condenser frame being distorted.

Stability Factors

A study of oscillators seems to indicate that if the harmonic content of the oscillator is maintained at a low level, plate voltage variations will cause only small changes in the operating frequency. By a systematic study of circuit constants it is possible to obtain excellent stability with respect to this variable. In some cases, by proper design, the frequency shift caused by a change in filament voltage can be made to be opposite that of plate voltage variation. The plate voltage coefficient (variation of frequency caused by a variation of plate voltage) for a master oscillator should not exceed ten parts per million for a plate voltage variation of plus or minus 10% in order that

Temperature coefficient of a 2-3 mc coil, overall temperature coefficient at 2 mc being 16.2 PPM/C°, and of a coil at 3 mc being 14.4 PPM/C°, showing frequency stability



good keying characteristics be obtained. When this coefficient is obtained voltage regulated power supplies are not needed and keying may take place in the plate circuit of the oscillator with good results.

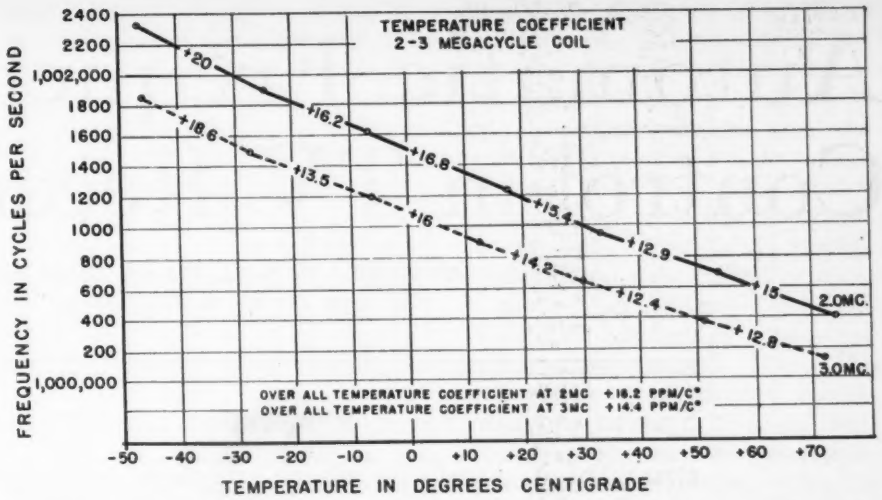
With the sealing of an oscillator it was found that the frequency of the oscillator changed with a variation in pressure. This was because the oscillator housing changed in dimensions causing a variation in the tank inductance. By placing an internal pressure shield this was reduced from a value of about 75 ppm for a change in pressure of 10 lb. per sq. in. to a negligible value when the pressure shield was installed.

When an oscillator is turned on from a cold start, several factors tend to cause a decrease in frequency: First an increase in the tube capacitance; second, a change in inductance due to the configuration of the current sheet of the coil due to a slight rise in temperature. These changes are minimized by using a large tank capacity, that is, a small L/C ratio. A permeability tuned oscillator is particularly adapted to such treatment since a constant capacity is used throughout the frequency range. By the use of small high temperature coefficient capacitors, it is possible to hold warm-up variations to a small value. In extreme cases, filament power may be supplied to a heating element associated with the compensating capacitor.

Thermal Stability

The frequency variation which is found during the warm-up of an oscillator is difficult to control in production. Since warm-up stability is related to overall temperature stability, the first problem is the elimination of thermal instability. The warm-up shift in frequency may then be held to a low value. By proper circuit design, it is possible to make the frequency either increase or decrease during warm-up; however, the amount of shift varies over the tuning range.

Table I lists the various stability factors and compares the capacity tuned and the permeability tuned oscillators. A check mark under the respective column heading indicates the type having superior performance. If the two are equivalent, a check is placed in both columns.



Temperature frequency of a 2-3 mc oscillator. Numerals in broken line represent the parts per million frequency change over various parts of the temperature range

It is the writer's opinion, that the permeability tuned oscillator has considerable advantage over the capacitor tuned oscillator. The overall accuracy of the capacity tuned oscillator may be 0.1% while the inductively tuned type may be designed to be less than 0.04%, from all causes including a temperature variation from —50°C to +50°C.

TABLE I

	Capacitance Tuned	Inductance Tuned
Humidity		#
Temperature		#
Vibration		#
Voltage variation	#	#
Pressure	#	#
Warm-up (5 min.)		#
Linearity of tuning		#
Size		#

Table II summarizes the frequency variations of a properly designed oscillator due to various ambient conditions. It should be pointed out that some of these variables produce frequency deviations in opposite sense and consequently the total percentage variation is usually less than the sum of the variables. These values apply to an oscillator having a 1.5 to 1 tuning range.

From the results as tabulated, the conclusion may be drawn that a properly designed master oscillator compares very favorably with a crystal controlled oscillator.

Fixed capacitors are used in the permeability tuned oscillator for the reasons discussed previously. These capacitors must be stable, sealed from moisture effects, and have the required temperature coefficient. Nearly all fixed capacitors exhibit small sudden shifts in capacity when subjected to a large temperature variation.

In addition to these small discontinuities, there is a large variation in capacitor slope, and shape of the temperature coefficient curve for most fixed capacitors. Mica capacitors are the worst offenders in this regard, but through the cooperation of the manufacturers of ceramic condensers, it was possible to secure the necessary characteristics.

The problem of testing these capacitors is quite involved and requires a special measuring technic. Since capacitors do not generally exhibit a linear change in capacity with temperature, it is necessary to specify temperature coefficients in terms of parts per million deviation for each 20°C change in tem-

(*Continued on page* 125)

TABLE II

Variable	Frequency Variation
Temperature —40°C to +60°C	.02%
Humidity (any amount)	.001%
Vibration 30 min. at amplitude of .015 in. at 10-55 cps	.0025%
Line voltage +10%	.0025%
Pressure 10 lbs./sq. in	.0005%
Warm-up	.0040%
Position with respect to earth's magnetic field	.0008%

Automatic Frequency-Phase Control in TV Receivers

By ANTONY WRIGHT, TV Section Manager, Home Instrument Div.
RCA Victor Division of RCA, Camden, N. J.

System permits receiver operation with no disturbance of line structure in locations where triggered syncs admit interference

● If the commonly used triggered type scanning oscillators are used, operating adjustment of television receivers becomes less critical as the synchronizing signal injection is increased. Tight locking to the signal will eliminate the need for an operating control. However, the necessary increase in the synchronizing signal injection to the scanning oscillator would cause the picture to break up more readily if subjected to interference from electrical devices operated near the receiver. In addition, when the desired signal is weak, the noise generated in the receiver and appearing as "snow" on the picture spoils the register of the picture elements, since noise impulses added to the synchronizing pulses will cause off-time firing of triggered scanning oscillators.

Consequently the design engineer faced two alternatives. First, the choice of light synchronization with a fair immunity from interference, but a critical operating control; or second, tight locking, such locking, with its less critical operating control, resulting in bad instability in the presence of interference.

Considerable work on this problem was undertaken by several inventors, which resulted in a new means for controlling the scanning oscillators. A dc control voltage was used, and was produced by a phase difference that existed between the receiver scanning saw-tooth voltage and the incoming synchronizing pulse. This was the beginning of automatic frequency and phase control and a very worth while improvement in immunity from interference was obtained. However, a manual control still was necessary to take care of the wide frequency diversion common to both blocking oscillators and multivibrators—types of oscillators generally used for the scanning generators.

The ultimate goal was a relatively inexpensive circuit which would frame the picture automatically and also would have the desirable noise immunity obtained by the automatic frequency and phase control circuit. Much experimen-

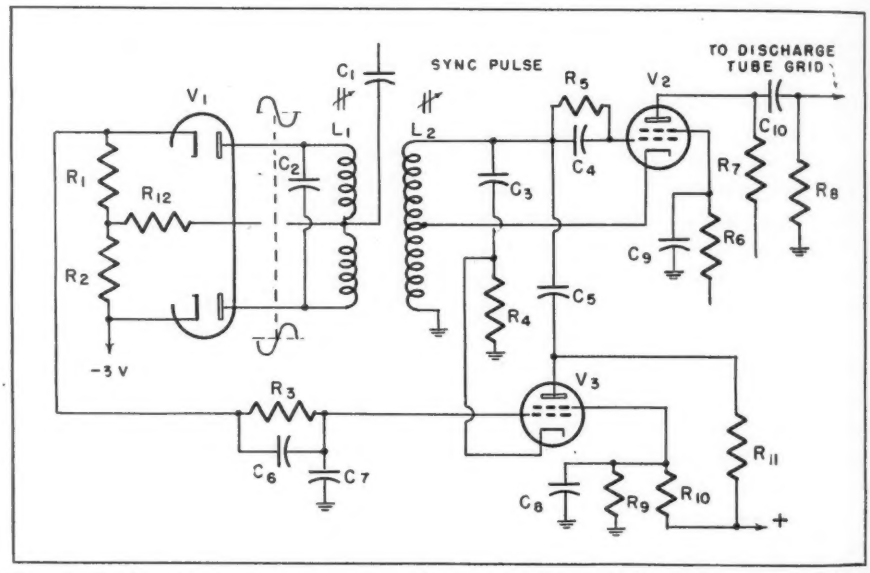


Fig. 1—Basic circuit for automatic phase control of horizontal scan oscillator

MOST television receivers in use today were produced before the war by a few manufacturers. These receivers, though limited in number, have been of considerable value to design engineers as a guide for the future products of the industry. A very definite complaint from the users of these receivers led to the production of an automatic device to maintain the horizontal line structure of the picture while the receiver is operating within a field of electrical disturbance. To the owner of a television set, the operation of synchronizing the picture is a confusing and troublesome adjustment, and an automatic means to remove the requirements for this operation is desirable.

tal work indicated the use of a highly stable scanning oscillator which would have flywheel action, and yet be subject to automatic control over a certain frequency range. This range could properly equal the standard frequency tolerances of the horizontal sync repetition rate allowed by the Federal Communications Commission.

Fig. 1 shows a circuit incorporating these ideas. It operates around V_1, the discriminator tube; V_2, the stable oscillator tube; and V_3, the reactance control tube. Basically, the aim is to provide a stable sine wave oscillator and compare the phase of the incoming synchronizing pulse with the generated sine wave. Slight variations in phase between these two produce a dc voltage to correct the oscillator and bring its frequency into proper relation to the synchronizing pulse.

An extremely stable Hartley oscillator is used in this circuit. It operates at the scanning frequency, 15,750 cps. The oscillator coil L_2 is closely coupled to the center tapped coil L_1, which is tuned by C_2 and adjusted to a slightly off resonance condition by the use of a movable iron core. With reference to the center tap of L_1, the induced voltages applied to the diode plates of V_1, to which the coil L_1 is connected, will be equal in amplitude and opposite in phase. The synchronizing pulse applied through C_1 to the center tap will appear on the diode plates equal in amplitude and phase. The sum of these voltages when the system is correctly phased are shown at (a) in Fig. 2. When this condition is obtained, both diodes will produce equal and opposite voltages across their load resistance R_1 and R_2. Therefore, the sum voltage across the two will be zero.

If the phase of the synchronizing pulse changes with respect to the sine wave, as in 2(b), the top diode will produce more voltage across R_1 than the bottom diode produces across R_2. Then the voltage across the two will be positive. In 2(c) the reverse condition to 2(b) exists. It is obvious from the foregoing that the dc output of V_1, the discriminator, can swing from positive, through zero, to negative depending upon the phase relation of the synchronizing signal and the sine wave.

DC Used for Control

This dc output together with a fixed bias are applied through an RC filter R_3, C_6 and C_7 to the grid of the reactance tube V_3, thereby altering its mutual conductance. Meanwhile this tube is producing plate current which is reactive with respect to the oscillator grid voltage. This is because its source is a sine wave voltage obtained from R_4 which is in series with the oscillator tank capacitor C_3. Changes of G_m in V_3 produce corresponding changes in the reactive plate current and since the plate of V_3 is connected to the tank coil L_2 through C_5, a change in grid bias applied to V_3 will produce a frequency change in the oscillator.

If the phase of the oscillator is not in proper relation with the synchronizing pulse, the dc voltage obtained from the discriminator thus will correct the oscillator. Capacitors C_6 and C_7 form a voltage divider to attenuate rapid changes in dc, such as are produced by the vertical synchronizing pulse or bursts of interference. Where the transmitted synchronizing signals are not sufficiently stable, a relatively fast response to fluctuations of the dc discriminator voltage is required. This response is determined by the ratio of C_6 and C_7.

Synchronizing is a precise function and any variation in the repetition rate of the synchronizing pulse is undesirable. Such variations can occur in the transmitter (video) because of stray coupling in the camera video and blanking mixer. This results in frequency modulation of the timing pulse generators, such modulation occurring and changing with the camera scene. In addition, a more frequent phenomenon is produced by coupling from the power supply to the timing pulse generators. This produces a 60-cycle or 120-cycle phase modulation of the synchronizing signal.

If either of such defects is present in the signal and if a receiver is equipped with a slow response automatic frequency and phase control circuit for horizontal syn-

Fig. 2—Sum of local oscillator and synchronizing pulse voltages which gives dc

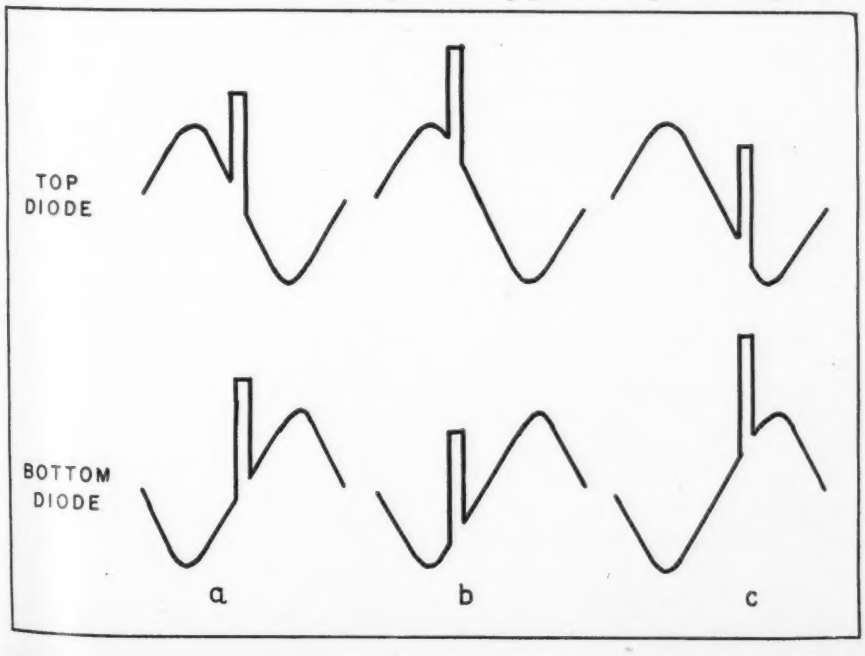
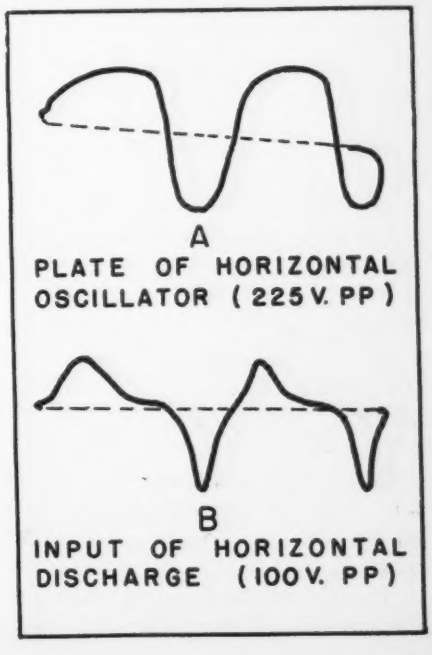


Fig. 3—Wave shapes which fire tube



chronizing, the following effects will be noted. Where the instability of the signal is due to picture information modulation, the received picture will show displacement of the horizontal lines corresponding to changes in scene. If a steady 60-cycle phase modulation is present, all vertical straight lines, such as telephone poles, will be curved in a more or less symmetrical bow. If 120-cycle phase modulation is present, the straight lines will be displaced twice and have an S shaped formation.

In the circuit of Fig. 1 such phase modulation is faithfully followed by the discriminator V_1, but the values of R_3, C_6 and C_7 can be chosen to remove this variation completely. This condition is desirable if there is little interference, but the removal of this variation will produce the described distortions of the picture in the vertical direction. Hence there is a choice of interference or horizontal line displacements, and it is necessary to sacrifice some interference immunity until such time as stable transmitting sync generators are in general use. Thus, a relatively fast time constant determined by the values of C_6, C_7 and R_3 is chosen.

Discharge Tube

A pulse must be obtained from the sine wave oscillator, to operate the discharge tube. To produce this the plate circuit of the oscillator tube V_2 is arranged as follows: The oscillator action takes place between the screen grid and cathode of V_2. The peak-to-peak value of the sine wave voltage on the grid is approximately 130 volts. This grid swing produces a square wave on the plate as shown in Fig. 3(a). This square wave is differentiated by capacitor C_{10} and resistor R_8 producing a wave shape as shown in Fig. 3(b). The positive portion of the differentiated square wave is sufficiently sharp to fire the discharge tube, in the normal manner.

The circuit has one other advantage. This concerns the return time of the deflection circuit. To phase the picture properly, the movable iron core of L_1 is adjusted so that the rectangular portion of the screen, illuminated by the scanning spot (raster), is blanked equally on both sides of the picture. Usually the discriminator circuit is tuned to a slightly lower frequency than the oscillator. At resonance, the circuit becomes unstable and so resonance is easily identified. When the inductance of L_1 is increased by its iron core adjustment until the correct phase of the picture is obtained, the alignment operation is completed.

By proper adjustment, the picture can be phased exactly and the return time of the deflection circuits may be slightly greater than when no phase control is available as in the other methods of synchronizing control. The pull-in or locking range of the circuit is ±200 cycles which is adequate to provide for the ± one per cent tolerance of horizontal sync repetition rate.

The photographs in Fig. 4 show the effects of receiver noise on the register of the picture. In 4(a) the picture was taken from the screen of an RCA TRK-12 which has triggered synchronizing. The vertical wedges are irregular although the set noise is not too objectionable. Fig. 4(b) was taken from the screen of an experimental receiver incorporating the new circuit, with more set noise present. The lines in the vertical wedge are straight and in perfect register. Fig. 5 shows the effects in a weak signal area 70 miles from the transmitter.

An experimental receiver equipped with a switch to change from triggered synchronizing control to automatic frequency and phase control was used to produce these pictures. Fig 5(a) shows the effects of local interference on

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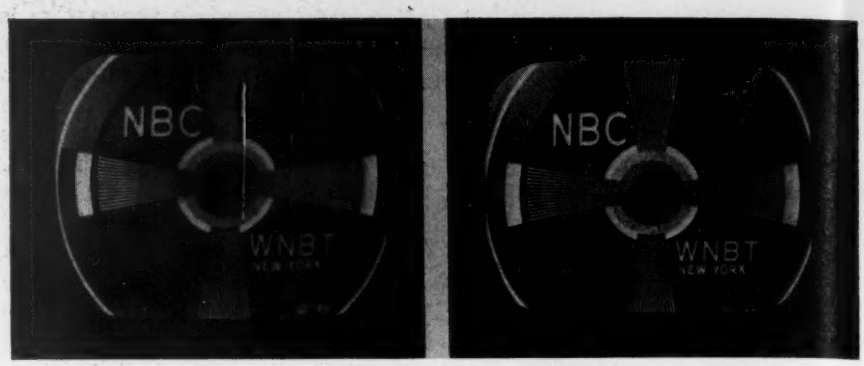

Fig. 4—Results on set using old circuit at a, left and new circuit at b, right

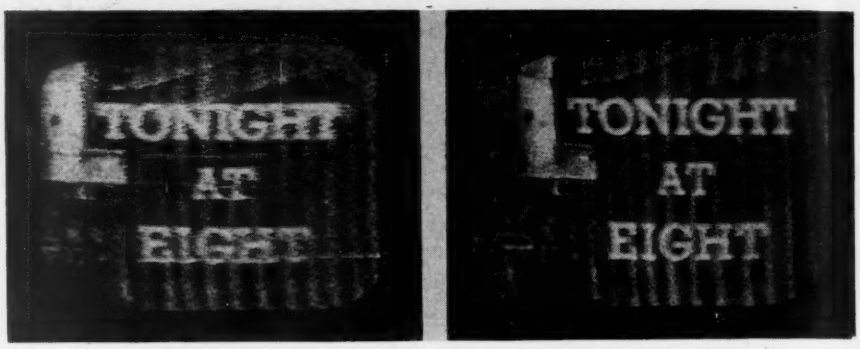

Fig. 5 — Results with weak signals using old circuit at a, new at b, right

Fig. 6—Door bell buzzer interference results. New circuit used at b, right

Television Interference With Shared Channels

By DR. ALBERT F. MURRAY,
Consulting Editor, Tele-Tech

With government services on one channel and non-government stations on all others, possibility of interference looms large

• Most engineers in the radio and television fields are familiar with the frequencies allocated to commercial television by the Federal Communications Commission. They know that thirteen channels have been set aside between 44 and 216 mc, and that each channel is 6 mc wide. The channels are contiguous except in two cases where they are interspersed with amateur, and Fixed and Mobile services. But relatively few engineers know that in all these television channels, numbered 1 to 13, other services can operate *on a "shared-channel" basis.*

Looking ahead to the time when television approaches the billion-dollar industry stage and all the channels are in use—and we are wishing for twice as many more—what will such channel-sharing mean?

First, let us examine the situation as it is today. How did this channel-sharing arrangement come about? It started with the radio industry itself. At the suggestion of the FCC, the industry organized the Radio Technical Planning Board in September 1943. The purpose of RTPB was to formulate sound engineering principles and to organize technical facts for the purpose of helping and advising the Government. An immense amount of work was done by a large and representative group of the country's radio engineers to correlate and place in usable form information bearing on the allocation of frequencies prior to the FCC hearing on this subject which began September 28, 1944.

Picture more than two score engineers, most of them coatless in the summer heat penetrating the large conference room of the New York City hotel where they had assembled for a meeting around a U-shaped conference table. At the head of the table was Dr. Jolliffe, chairman of this meeting of Panel 2, RTPB. Before them was the final and most difficult task of the year, namely, the fitting of the tremendously varied requirements of all the non-government radio services in the U.S.A. into the limited band of usable frequencies between 10 kc and 30,000 mc. They were working to meet a deadline.

> *"PROVISION may be made for the operation of non-government fixed and mobile services (such as police control and relay circuits, forestry fixed circuits, rural telephone, broadcast studio-to-transmitter links, railroad terminal and yard operations) upon proper showing of need and that these channels may be shared on a mutually non-interfering basis."*—FCC.

Panel 2 had considered without approval, two previous allocation plans in an attempt to satisfy expanding older services plus new services such as FM, railroad, police, taxicab dispatching, aircraft, television, rural telephone, forestry, and the like. The demands for part of the very wide space on the frequency chart set aside for TV were insistently pressed by the "short-haul" communication services which require only narrow channels for speech. Chairman Jolliffe very wisely maintained that as many as possible of the 30 channels requested by the television panel be reserved for this important TV service, which although not yet in wide use, would

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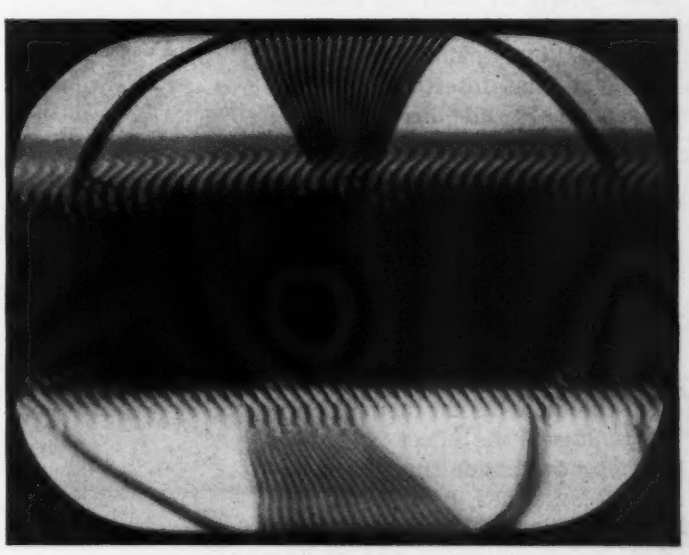


Photograph submitted to FCC by G. L. Beers of RCA to show effect of diathermy interference on picture reception. Field strength was 840 microvolts, receiver was the new RCA set which has 200 microvolt sensitivity; interference measured 810 microvolts; 2 to 10 microvolts interference can be seen in the picture.

some day become *the* way of placing radio sight and sound in millions of American homes.

The outcome was a compromise. In the Panel's final report it was recommended to the FCC that other communication services be allowed to share the television channels on a non-interfering basis. This plan was adopted and put into force by the FCC.

Sharing Services

What services are likely to share all of these frequencies assigned to television? *Government* services, fixed and mobile, share TV Channel No. 7. For all other channels, *non-government* fixed and mobile services are the sharers. An FCC note referring to these appears in the box on the preceding page.

At present, TV transmitters in a given area are assigned to only *every other* channel because the effect on television receivers of adjacent channel interference is not completely known. The services sharing with TV will be assigned to the alternate, unused channels. It is believed that any potential interference to television from such *fixed* stations, for example police relay, forestry, railroad terminals, etc., will not be noticeable, or at least can be taken care of by engineering means.

It is the *mobile* installation found on trucks, buses, police cars and taxicabs, that might interfere with television reception. The reasons these transmitters can cause more trouble than those that are fixed are: (a) they would be operated in urban and suburban areas very near homes where TV receivers would be in use, (b) transmission would not be beamed but would be omnidirectional, so that interference might be caused in all directions, (c) vehicles carrying transmitters licensed to operate in a certain area, say Philadelphia, might enter another area such as New York City where telecasting was on the same frequencies used by the vehicles. (TV stations in New York City and Philadelphia are on adjacent channels).

On the other hand, factors tending to lessen the effect of mobile interference include the low transmitting antennas (unless the vehicle were driven to some point of high altitude); the low transmitter power, 15 to 50 watts; the relatively brief duration of the interference due to the movement of the vehicle along the highway (unless parked); and the usual long pauses between rather brief transmissions. Certainly it should not be as bad as the television interference now resulting from the customary 20-minute diathermy treatment!

What is being done about this situation today? The television industry should know that the Commission and its engineering department are fully aware of the situation. They are proceeding cautiously. Thus far, only a very few temporary authorizations to transmit in the television channels have been issued to other services. The Pennsylvania Turnpike holds such authorization for its transmitters. However, there are requests from the group known as Special Services. Taxicab dispatching by radio has been so successful that companies planning to operate 1000 radio-equipped cabs are pressing for FCC licenses. It is true that the two frequencies at present assigned in some cities for this purpose are overcrowded. Taxicabs in New York City and in Chicago would like space in the TV channels.

The television engineering department of the FCC has requested from TV receiver manufacturers selectivity curves and data on co-channel and adjacent channel interference limits. This will aid the FCC engineers in their study. They realize that at present too few TV receivers are in the hands of the public for field tests to indicate the degree of interference which might be encountered in the future. In FCC's standards of good engineering practice objectionable interference is said to exist for TV reception if, on the same channel, the ratio of desired to undesired signals is 100:1, or 2:1 for adjacent channel separation.

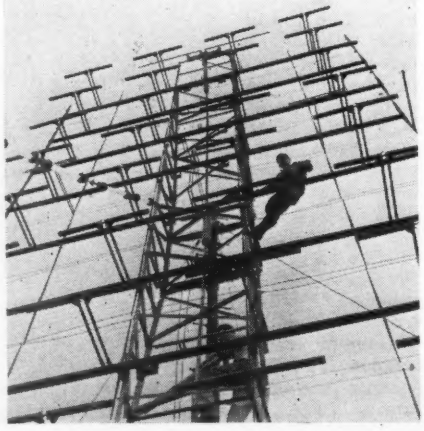
Diathermy Interference

In the December 1946 FCC hearing on diathermy interference, testimony was given indicating that the current model RCA television receiver will operate satisfactorily on signals as low as 200 microvolts, and that under such conditions, interference of 2 to 10 microvolts can be seen on the television screen. According to photographic evidence, when the interference was one-fourth as strong as the signal, the picture became unusable. This illustrates the high degree of suppression of interference necessary to prevent complaints from TV set owners, especially in suburban locations where they can use the full sensitivity of their modern receivers.

Two thoughts to be passed on to those studying the problems arising from the sharing arrangement follow. First, find the best way to make use of the difference in polarization of the desired TV waves, which are horizontally polarized as

(*Continued on page* 119)

Radar Serves for Propagation Tests



A former Army SCR-271 radar antenna installed in the roof of 444 Madison Avenue, New York, is being used by the WOR engineering staff in cooperation with the Federal Communications Commission to test the propagation characteristics of radio waves in the 47 and 106 mc regions for stability and to study the effects of cosmic storms, magnetic storms, sun spots, and seasonal changes. WOR's Jack R. Poppele states that the radar antenna enables measurements up to 90 kw.

Frequency Multiplier Circuit

By W. C. BROWN, Signal Corps. Engineering Labs. Bradley Beach, N. J.

Half wave polyphase rectifier followed by a high Q wave re-shaping circuit gives extreme frequency selectivity; simple to construct and operate

• There are numerous methods of frequency multiplication, each one having its own particular merits and demerits. Described here is a method of frequency multiplication, using well-known and commonly-used circuits, but like all others it has its advantages and faults. In its favor are the following: (a) It is very simple to operate; (b) it always gives exactly nF in its output; (c) it completely removes all traces of the fundamental; (d) it is easy to construct.

To its disadvantage, it is extremely frequency selective (probably phase sensitive would be a better term), has low efficiency and three or four of the components used in its construction must be of very high quality.

Fig. 1 shows the schematic of a tripler. The values shown in the caption were used in tripling a 620 cps input. A casual inspection of the circuit will show that the device is simply a half-wave polyphase rectifier followed by a high Q wave reshaping circuit. In this unit three voltages of equal

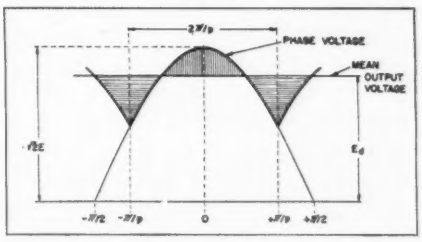


Fig. 4—Relative efficiency curve

magnitude, but each differing in phase by 120°, are applied to the three half-wave diodes. The phase shift is obtained from simple RC networks. The equation for values being given by:

$$\theta = 2 \tan^{-1} \frac{X_c}{R} \qquad)$$

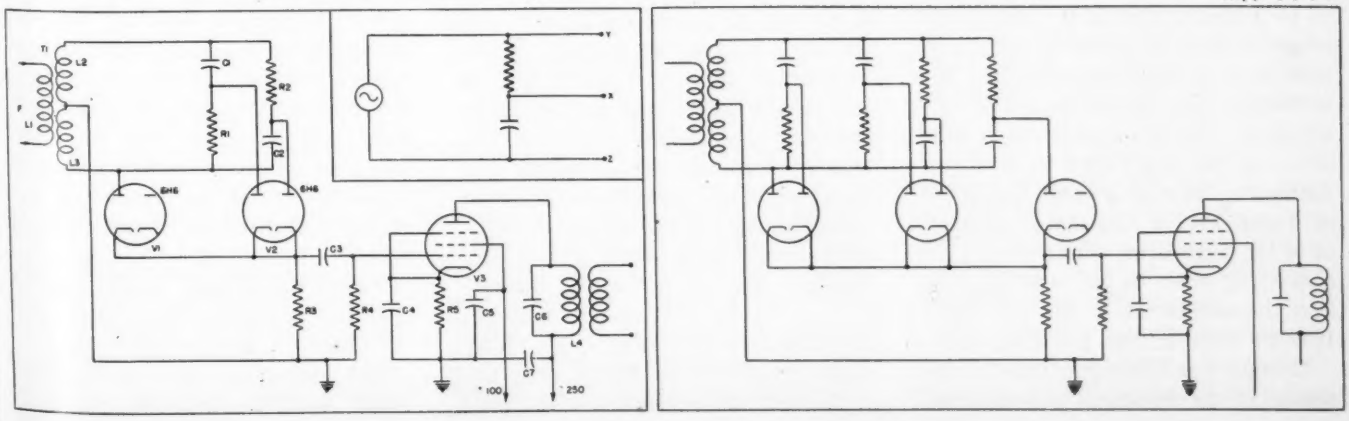
It might be in order briefly to review a few elementary considerations concerning RC networks connected into ac circuits. Consider Fig. 2 for a moment. Across X and Y will appear a voltage in phase with the current through R. Across X and Z will also appear a voltage, but it will lag the cur- through C by 90°. Thus there result two vectors, e_r and e_c, out of phase by 90° and whose individual magnitudes depend upon R and X_c, respectively. Simple vector addition gives a resultant vector, whose magnitude is a function of the magnitudes of the individual vectors and whose angle is a function of R/X_c.

Two facts immediately become apparent from the above. First, the magnitude of the resultant vector varies inversely as R and X_c and transposition of R and C (Fig. 2) will invert the function of phase angle change as R is varied.

Rissik has published in *The Electrician* of August 11, 1939, a rather complete analysis of harmonic voltage generation in polyphase rectifiers. He shows that the output of such a system may be considered as a dc voltage E_d upon which is superimposed an alternating ripple composed of several harmonics of the fundamental, and each of a different frequency and amplitude. The dc component is of no interest in this application and is removed by condenser C_3, Fig. 1.

(*Continued on page* 127)

Fig. 1—Schematic of the tripler, values being: R1, 1158; R2, 4038; R3, 100,000; R4, 100,000; R5, 1200; C1, .1; C2, .1; C3, .01; C4, 12 mfd; C5, 12 mfd; C6 to resonate at 3F; V1, 6H6; V2, 6H6; V3, 6SJ7; L1, L2 and L3, 3-winding step-down transformer; L4, Low C air coil to resonate (with C6) at triple F. Fig. 2 (inset)—Elementary RC network; Fig. 3 (right)—Schematic of a quintupler



Survey of Wide Reading

Electronic news in the world's press. Review of engineering, scientific and industrial journals, here and abroad

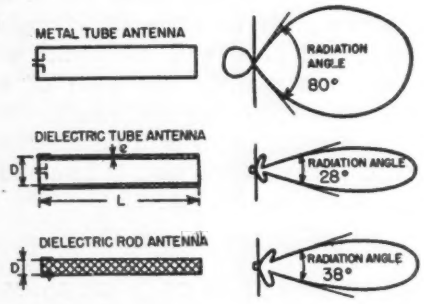
German Dielectric Antennas

(L'Onde Electrique, Paris, France, October, 1946, pages 387 to 390)

General information is given on the dielectric antennas developed by the Germans for decimeter and centimeter waves. These antennas consist of dielectric tubes or rods and are said to be more directional than a metallic waveguide of the same dimensions, see figure.

A dielectric guide, dissimilar to a metallic guide, radiates along its entire length as well as at its open end, and therefore its length and the propagation velocity of the wave along the guide will be of influence on the final radiation pattern. It is stated that a magnetic type wave must be used.

If a tube is used, an increase in length will improve its directional characteristics; however, a length



of six times the wavelength appears to be a maximum value. Dielectric constant and thickness of tube wall also play an important part in determining the performance of the antenna. For a 10 cm wave, a tube 30 to 70 cm long and 9 to 12 cm in diameter, having a wall thickness of 4 mm and a dielectric constant of 4, is suggested. The radiation angle will then be 50 to 25 degrees and the amplitude of the side lobes 16% of that of the principal lobe.

Though the dielectric tube is superior in its electrical characteristics, the dielectric rod has better mechanical properties. Along rods having a diameter less than $\lambda/3$, the propagation constant in the rod equals that in air, as is desirable for this type of antenna. A dielectric rod antenna for a 12 cm wave may be made 20 cm long, have a diameter of 5.7 cm, and a dielectric constant of 2.5; then the radiation angle will be 55° and the maximum of the parasitic radiation 20%. The rod is mounted in a metallic sleeve which also serves as feeder for the antenna. A tapered version of the dielectric rod antenna improves the directivity. (Radiation angle 42° for a length of 3.3 wavelengths.)

In general a bandwidth extending down to half the high frequency is admissible, while a frequency variation of 10% hardly affects the antenna performance. Antenna arrays with several suitably aligned dielectric tubes or rods have been investigated and found to result in increased directivity, as is to be expected. Eight rods make possible a radiation angle of 5°.

High Frequency Transmission in Cables

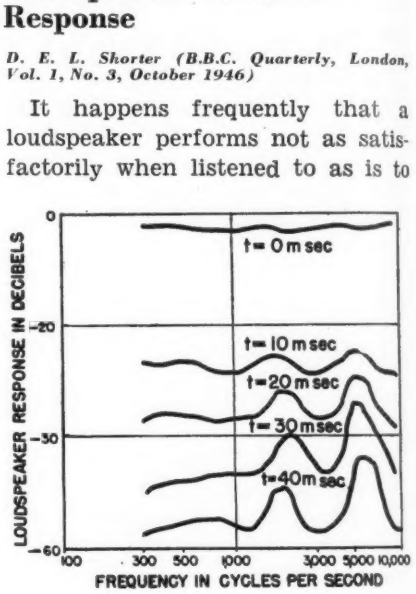
M. Bendayan (Bulletin de la Societe Francaise des Electriciens, Paris, France, 6th Series, Vol. V, No. 44)

The effect of irregularities in cables at high-frequency (approximately 4 mc) waves is studied. Irregularities within a cable section and those appearing at the junction of individual sections are treated. Reflected waves which disturb telephone circuits and twice reflected waves, which are particularly harmful in television transmission, are investigated. Statistical methods are used to connect the measured values with the many small irregularities which may affect short wave propagation.

Loudspeaker Transient Response

D. E. L. Shorter (B.B.C. Quarterly, London, Vol. 1, No. 3, October 1946)

It happens frequently that a loudspeaker performs not as satisfactorily when listened to as is to



be expected from its frequency response curves. An attempt was made to correlate the measured data more closely with the quality index obtained from the aural tests.

Considerations indicated measurement of the loudspeaker frequency response curves at specified time intervals after the loudspeaker has been cut off suddenly. The loudspeakers under test were suddenly connected and disconnected to the supply for intervals of approximately 1/20 second. Signals picked up by a microphone were recorded at given delay times after the loudspeaker had been cut off. This method permitted establishment of response peaks (at 2000 and 8000 cycles per second in the example shown) at some time (30 and 40 milliseconds) after cessation of the input signal. These delayed response peaks are held responsible for observed aural disturbances.

The apparatus used to measure these delayed response curves is

described and curves obtained are reproduced and discussed. Further research on loudspeaker response along the lines indicated is contemplated to establish a method of measurement giving results close to those obtained from listing tests.

Design of IF Transformers for FM

H. A. Ross (Amalgamated Wireless of Australia, Technical Review, Sydney, Australia, Vol. 6, No. 8, 1946, pages 447 to 471)

The design criteria for intermediate-frequency amplifiers in frequency-modulation receivers are: gain, linearity of phase-frequency characteristic and amount of amplitude modulation exceeding limiter cut-off introduced by the transformer. Coupling coefficient, k, and quality factor, Q, of the transformer are the unknown data.

The bandwidth at a given attenuation is a maximum if primary and secondary quality factors are equal and this is assumed throughout. The first figure illustrates the phase shift due to the transformer between the secondary current at center frequency, f_o, and the secondary current at another frequency, f, as a function of relative frequency deviation, $(f_o - f)/f_o$, times the quality factor, Q, for different coupling conditions. The desired linear phase-frequency characteristics are shown by the dashed

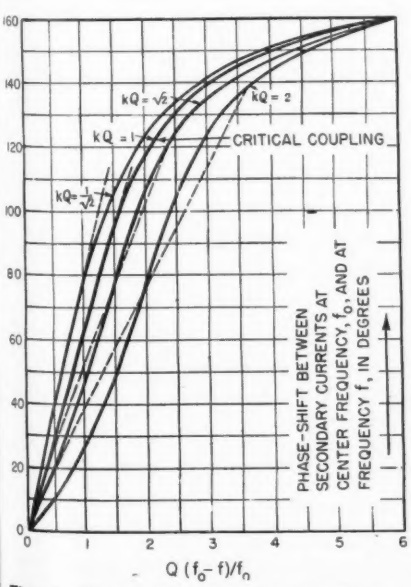

kQ = √2
kQ = 2
kQ = 1
CRITICAL COUPLING
kQ = 1/√2
PHASE-SHIFT BETWEEN SECONDARY CURRENTS AT CENTER FREQUENCY, f_o, AND AT FREQUENCY f, IN DEGREES
Q (f_o - f)/f_o

Fig. 1—Phase-shift due to transformer

lines; maximum linear range occurs for $Qk = 1$, i.e., for critical coupling which also facilitates alignment. The linear range of the phase-frequency characteristic should be made wide enough to accommodate all significant sidebands.

It is assumed that the transformer reduces the current amplitude I_o at the center frequency to a value I_o/r at a frequency different from the center frequency, f_o, by twice the maximum frequency deviation, $2\triangle f$. Amplitude modulation will then be caused by passage of the frequency-modulated wave through the transformer. The second figure illustrates the percentage of amplitude-modulation, A, for critical coupling, as a function of the quality factor, Q, times twice the relative maximum frequency deviation from the center frequency, $2\triangle f/f_o$. The four curves refer to one, two, three, and four identical, transformer-coupled stages, respectively.

To design a transformer for the intermediate frequency stage of an

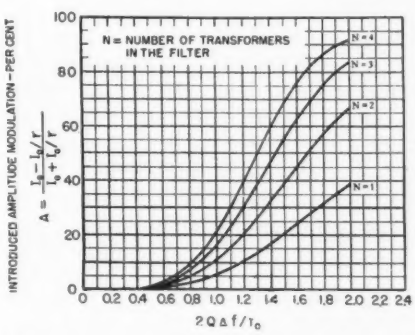


Fig. 2—Percentage of amplitude-modulation introduced by i.f. transformer

FM receiver, the intermediate frequency, f_o, and the maximum frequency deviation, $\triangle f$, are known; coupling factor, k, and quality factor, Q, are the unknown variables. No generally acceptable limit for the percentage of introduced amplitude modulation, A, can be given, the permissible amount varying for each specified case. However, a value of 0.33, corresponding to 6 decibels attenuation at a bandwidth equal to twice the maximum frequency deviation, is an average value in current practice.

The final formula for Q is:

$$\frac{Q\triangle f\sqrt{2}}{f_o} = \left[\left(\frac{1+A}{1-A}\right)^{2/N} - 1\right]^{1/4},$$

where N is the number of identical stages. For critical coupling, k may be found from $k = 1/Q$. A numerical example is given.

The second figure permits immediate evaluation of the quality factor, Q, for a maximum admissible

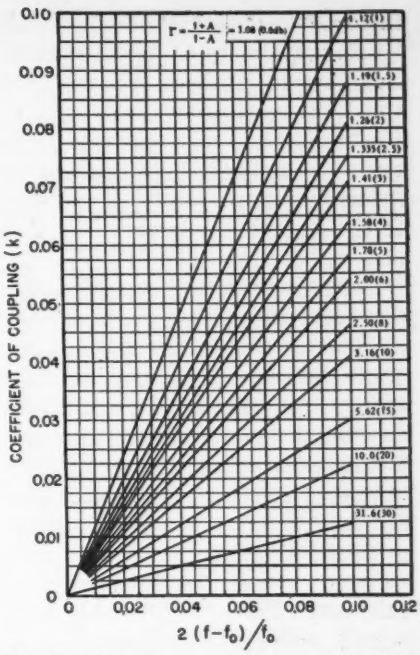


Fig. 3—Coupling coefficient as function of relative frequency deviation with current reduction ratio as parameter

amplitude modulation, A, a given number of identical stages, N, the relative maximum frequency deviation, $\triangle f$, and an intermediate frequency, f_o.

In the third figure, the lines of constant current attenuation, r, are drawn, abscissa and coordinate are twice the relative frequency deviation, $2\triangle f/f_o$, and the coupling coefficient, k, respectively.

Stage gain, conditions for overcoupled transformers, and power relations are considered in an appendix.

German Infrared Equipment

V. Krizek and Dr. V. Vand (Electronic Engineering, London, October 1946, pp. 316, 317, 322)

The Germans developed infrared interception technics which serve the same purpose as radar. Small resistance-type photocells were specially designed to serve as infrared detectors; they were mounted in the focus of a parabolic mirror.

In the infrared telescope an infrared image projected on a transparent photocathode emits electrons according to the intensity of the radiation at each point. The released electrons are used to produce a corresponding visible picture on a fluorescent screen. A tenfold energy gain of the infrared radiation may be obtained.

The infrared iconoscope uses a semi-conducting layer, the resistance of which changes with the

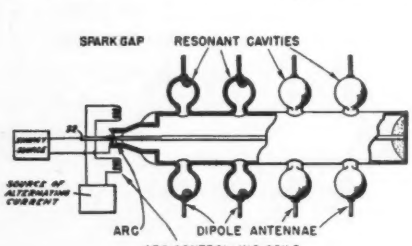
infrared illumination intensity. When scanned by an electron beam, the current changes according to the local resistance of the spot hit by the beam. The current variations are amplified, permitting the infrared picture to be transferred to the fluorescent screen of a cathode ray oscilloscope.

The photosensitive, semi-conducting layer of the "electron mirror" apparatus also changes its resistance with the infrared light intensity. A broad electron beam charges the high resistance spots to a comparatively high negative potential while low resistance spots are only charged to a low negative potential because the impinging electrons are conducted away. Further electrons will be strongly reflected from the high resistance, negatively charged regions; the reflected electrons are focussed on a fluorescent screen which is viewed.

Spark Gap Oscillator

E. Labin, International Standard Electric Corp., (F) March 13, 1941, (1) August 6, 1946, U. S. Patent No. 2,405,217

To generate high frequency impulses having a relatively short and controlled duration compared to the recurrence frequency of the pulses, an arc discharge is established alternately between terminal 32 and the inner and outer conductor of a concentric transmission line. The change-over of the arc is controlled by the ac or pulsed current in two coils adjacent the end of the transmission line. Spark discharges occur at regular intervals determined by the source frequency or period. These discharges cause highly damped waves to travel down the concentric transmission line which is terminated in its characteristic impedance to eliminate return of the wave. As the wave passes the



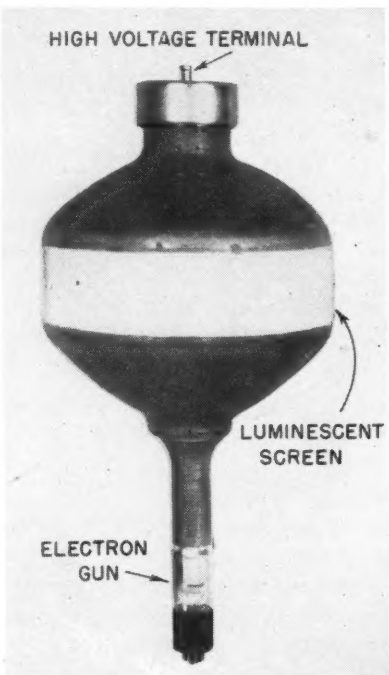
apertures, the coupled cavities will be excited to oscillate at their resonant frequency.

Duration of these oscillations is controlled by the Q-value of the resonant cavities, so that the oscillations may be maintained longer than the duration of the spark gap discharge by designing the cavities for a sufficiently high Q-value. Energy will be radiated by the separate dipole antennas, coupled to the resonant cavities and spaced for desired directivity of the transmitted wave. An alternative arrangement incorporates a single resonant cavity with a number of coupling apertures connecting the cavity and the coaxial transmission line. Any other pulse generating device may replace the spark gap pulse source described.

A Cathode-Ray Tube for Viewing Continuous Patterns

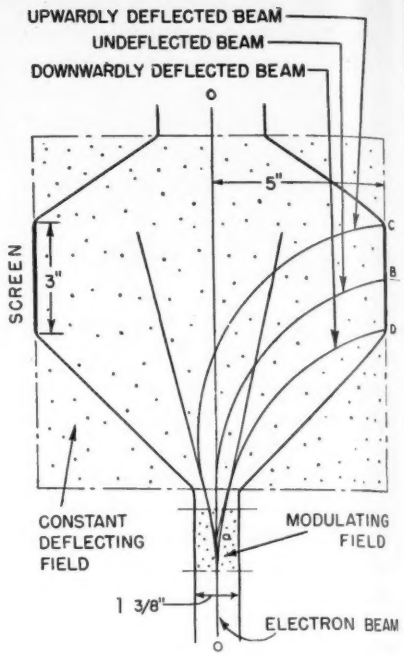
J. B. Johnson (Journal of Applied Physics, November, 1946, pages 891 to 894)

A cathode-ray oscilloscope with a persistent after-glow screen phosphor was designed for continuous



viewing of, for instance, visible speech patterns. In this tube the time axis is generated by rotation about the vertical axis of the cylindrical screen which is applied on the cylindrical circumference of the tube. The tube as a whole is rotated at a constant rate of one to twelve revolutions per minute.

A constant stationary magnetic bending field, oriented at right angle to the tube axis, focuses the electron beam on the centrally located circular line (B) of the screen as it moves past the beam. A con-



Cylindrical screen cathode-ray tube for continuous viewing of changing pattern

siderable section of the screen is viewed while it is fluorescing, however, the image has faded before the screen area again faces the electron beam.

Below the bending field coils and outside their main field is mounted the deflecting yoke which consists of a pair of modulating coils located above the electron gun. Bending field and modulating field are closely parallel. The electron beam is deflected away from the tube axis by an amount depending on the modulating field. As will be seen from the sketch, electrons leaving the axis will impinge on the screen either above (C) or below (D) the center circular line (B).

Iconoscope Theory

R. Barthelemy (Comptes Rendus, Paris, August 27, 1945, pp. 245 to 247)

The results of a year of research on the details of operation of an iconoscope are reported. Correlation betwen theory and observations are discussed. First the potential of an isolated disc bombarded by a high velocity electron beam is computed, involving the study of secondary electron emission. Space charge effects are considered and equipotential surfaces in front of the charged disc are plotted. A maximum voltage of three volts and a minimum of - 0.5 to 1.5 volts, depending on beam intensity, is arrived at.

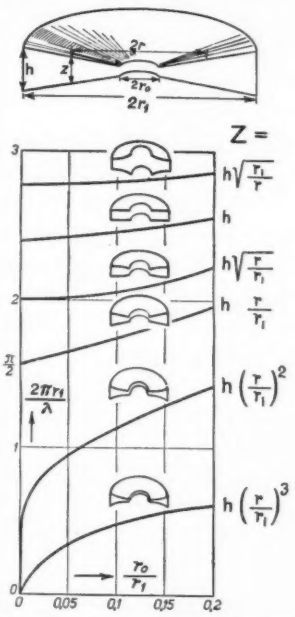
Iconoscope sensitivity is com-

puted as a function of cathode ray intensity and light intensity. The light intensity establishes an upper limit for the signal amplitude. The study permits an explanation of the parasitic potential on the mosaic which may attain 25 per cent.

Flat Cavity Resonators

C. G. A. von Lindern and C. de Vries (Philips Technical Review, Eindhoven, Vol. 8, No. 5, pp. 149 to 160)

The voltage and current distribution and the resonant frequencies of electromagnetic waves in flat cavities of various cross-sections and with a circular central opening are derived from the equations of a Lecher-wire system. In the figure the values of $2\pi r_1/\lambda$ (which are proportional to the fundamental resonant frequency) are plotted against r_o/r_1 (the ratio of the inner to the outer radius) for cavities of various shapes as illustrated next to the respective curve. The formula for the height, z, of the particular cavity as a function of the radius, r, for a given peripheral height, h, is noted on the right-hand margin.



Dependence of fundamenal resonance frequency on relative size of central circular opening for differently shaped cavities

The left-hand points of each curve, corresponding to r_o equal to zero, refer to closed cavities with no central opening; the radius, r_o, of the central opening for the right-hand points of each curve is one-fifth of the cavity radius, r_1. The quality factors of these resonators are also discussed. A 65 cm oscillator, a 45 cm amplifier, and a velocity modulation tube for 40 cm waves, all incorporating similar resonators, are described in some detail.

Ion Traps in CR Tubes

J. Sharpe (Electronic Engineering, London, England, December, 1946, pages 385, 386)

Methods for preventing damage of the cathode-ray tube screen by ion bombardment are reviewed. Ions may be separated from the electrons by magnetic deflection (inclined electron gun, crossed electrostatic and magnetic fields), electron focusing by a magnetic field and passage through a small aperture, and absorption of the ions by a thin film of material such as a layer of aluminum evaporated onto the screen, or an overbinder such as potassium silicate.

Film, Television Tube, and Eye Are Compared

A. Rose (Journal of the Society of Motion Picture Engineers, October, 1946, pp. 273 to 294)

A unified approach is sought to describe the performance of photographic film, television pickup tubes and the human eye. When it is recognized that resolution, sensitivity, and contrast discrimination are essential properties of all three devices, a comparison between them is facilitated. Based on an idealized model incorporating the common features of these light sensitive structures, a general terminology is adopted and a common expression for the quality of their performance is found.

Irradiation of ZnS Phosphors

W. de Groot (Physica, The Hague, Holland, Vol. XII, No. 6, September, 1946, pages 402-404)

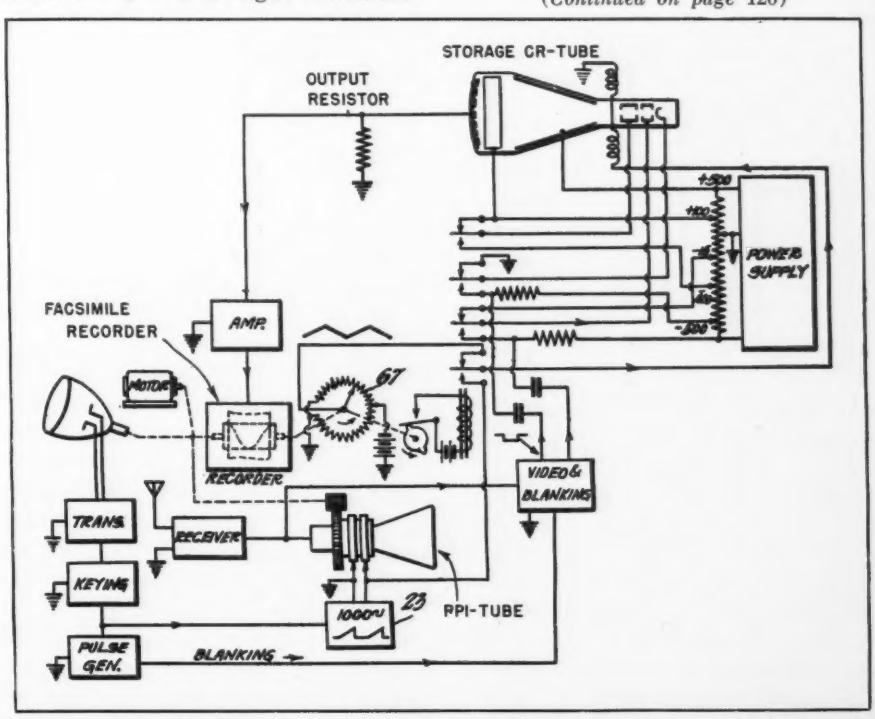
The effect of ultraviolet irradiation on the light emission and on the dielectric constant of ZnS phosphors was made the subject of an experimental investigation. The tuning capacitor of a multivibrator was coated with the phosphor and the detuning upon irradiation measured by a beat frequency method. A caesium photocell was mounted opposite the capacitor coating and its amplified output indicated by a galvanometer. It appeared that after-effects are much more strongly noticeable in the intensity of the emitted light than in the change in dielectric constant.

Radar Recorder Using Storage CR-Tube

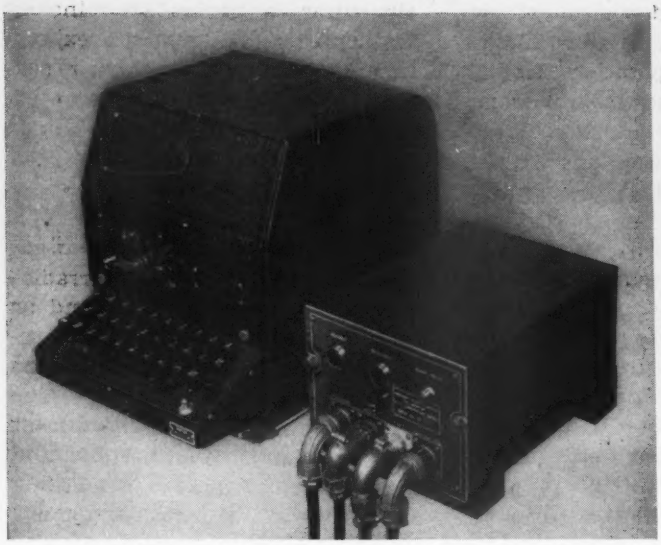
J. P. Smith, RCA (F) August 30, 1943, (I) July 9, 1946, U. S. Patent No. 2,403,562

A strip map is obtained by continuously recording the radar reflections from objects located (within 10 deg. angle) to the right and to the left of the instantaneous position of a moving radar equipment; no records are made of objects located outside of the 10 deg.

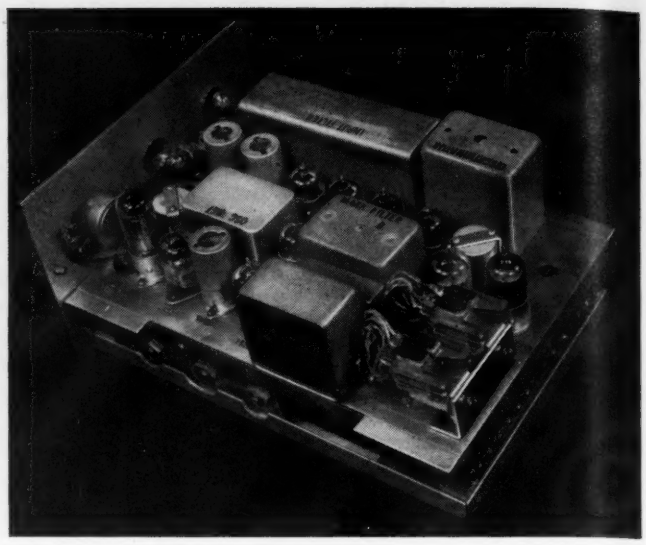
(*Continued on page* 120)



Strip map recorder based on radar technique using storage type cathode-ray tube



New teletypewriter with associated converter-control unit



Interior view of converter-control used with radio circuits

Light Weight Teletype Unit for Mobile Use

Smaller than standard typewriter, equipment uses regular keyboard and keying code—Control converts code to frequency shift signals

NEW lightweight teleprinter equipment extends the usefulness of the system to include mobile service in airplanes, trucks, for marine service and in military operations where a printed record of instructions, orders, etc., may be received without continuous attention from an operator and without the need for skilled operators.

• Teletype equipment, rapidly coming into wider use in many communications fields, has been somewhat restricted in usefulness due to the relatively great weight and bulk of the units and the space needed for their operation. Now, however, Teletype Corp. has developed a printer unit that actually is smaller and lighter than a standard typewriter, thus greatly extending the field of usefulness of the equipment which now becomes available for operation in airplanes and in earthbound vehicles where space is at a premium. An associated converter-control unit to operate with the new printer has been developed by Bell Telephone Laboratories; R. A. Vanderlippe, supervisor responsible for the development of radio teletype systems for the Laboratories, tells of both units in the November issue of "The Record".

The new printer uses the regular teletype keyboard and keying code. The converter-control unit at a station which is sending changes this code into frequency-shift signals in the audio frequency range for transmission over existing radio telephone equipment. At the receiving station, the converter-control unit changes the frequency-shift signals into impulses for operating the receiving-typing part of the printer.

The new instrument will work with any existing radiotelephone installation capable of carrying on satisfactory two-way voice communication. This, of course, means that by the simple addition of the radio teletype equipment, weighing less than thirty-five pounds, and without any modification of the radiotelephone equipment, two-way, typed communication, with all its advantages, may be achieved. The normal use of the radiotelephone equipment is in no way affected by the installation of the radio teletype.

As in standard land wire teletype equipment, two signaling conditions commonly referred to as "marking" and "spacing," are used for transmission of teletype signals. The unit of time during which a character is transmitted is broken into seven intervals. Each character begins with a spacing "start" interval and ends with a

marking "stop" interval. During these intervals all printers which are receiving are synchronized with the printer which is sending.

During each of the five time intervals between the start and stop intervals, the signaling condition may be either marking or spacing, depending on the teletype character being transmitted, so that thirty-two different signaling combinations are possible. By assigning one combination for "upper case" and one for "lower case," any or all of the remaining thirty combinations may be used for the transmission of either of two characters or symbols so that there are enough combinations for all characters and symbols on the keyboard of the teletypewriter.

Frequency Shift

Circuits in the converter unit provide an automatic closure to condition the radiotelephone equipment for transmission when the first teletype character is sent. This function is disabled when a message is being received. Other control circuits provide for holding the selector magnet circuit of the teletype printer in a marking condition during idle periods of the circuit, so that radio noise will not cause false characters to be printed, and to light lamps to indicate whether the terminal is in a transmitting or a receiving condition.

Openings and closures of the printer transmitting contacts which occur as the keyboard is operated are applied to the sending circuit and shift the frequency of an oscillator between 1,615 and 1,275 cycles as required by the marking and spacing elements of the character to be transmitted. The output of the sending circuit modulates the radio transmitter in the same manner as a voice signal. A small amount of energy from the sending circuit is applied to the receiving circuit in which it functions in the same manner as a signal received from a distant station. In this way, a local copy of the teletype characters being transmitted is obtained. During transmission, the auxiliary contacts of the teletypewriter close during each character and, operating through the control circuit, cause the press-to-talk control circuit of the radio transmitter to close at the beginning of transmission and remain closed as long as at least one character is sent every five seconds.

Release of the mark-hold circuit during a receiving condition causes

Light weight and small size make equipment suitable for airborne and mobile use

a green-capped "rec" lamp to light. At the same time that the marking hold is released, the sending control circuit is disabled to prevent accidental operation of the keyboard from interfering with the incoming signals. During the transmitting condition, a red-capped "send" lamp is lighted and the circuit for lighting the "rec" lamp is disabled.

When signals are being received, the 1,615-cycle marking and 1,275-cycle spacing tones, together with the important side band components resulting from signaling, are passed by the input band pass filter to a fast-acting amplitude-limiting circuit and applied to frequency-discrimination circuit.

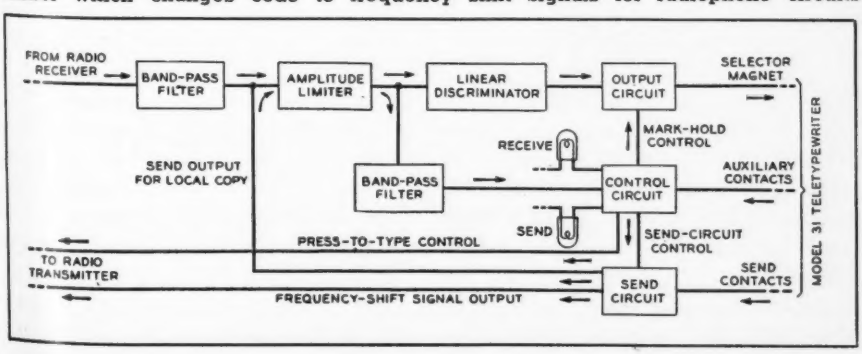
Operating System

The output of the discriminator circuit is a positive voltage for marking and a negative voltage for spacing signals which result in a current of 20 milliamperes in the selector magnet for a marking condition and zero current for a spacing condition.

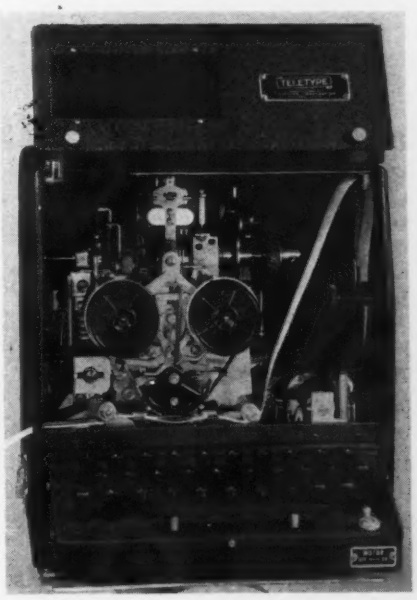
The output of the amplitude limiter is also applied to the "mark-hold" circuit. The marking elements of the first teletype character to be received cause the marking hold on the output circuit to be released so that subsequent signals may pass through the output circuit to the printer selector magnet.

The Model 31 teletype printer is 10½ in. high, 10 in. wide and 13½ in. deep, and weighs only 24 lb. The converter-control unit is 5 in. high, 7 in. wide and 9 in. deep, and weighs 8 lb. This makes it possible to provide teletype service over existing press-to-talk radiotelephone circuits by adding less than 35 lb. to the weight of the communications equipment. No modification of the radiotelephone equipment is necessary.

Block diagram of the new teletypewriter equipment and its associated converter-control which changes code to frequency shift signals for radiophone circuits



Interior view of light weight teletype



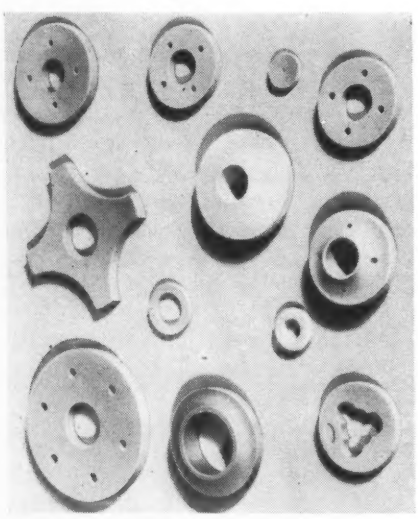
Low Loss Ceramic Dielectric

By DR. HANS THURNAUER, Vice President-Research,
American Lava Corp., Chattanooga, Tenn.

AlSiMag 243 combines low dielectric constant, low power factor and good mechanical strength and may be processed by standard Steatite methods

• Important electrical requirements for a good dielectric or insulating material used in high frequency circuits are electrical resistivity and low dielectric loss factor. Whereas resistivity is relatively easy to obtain, low loss factor can only be found in certain types of insulating materials.

Among ceramic insulating materials, Steatite ceramics have long been recognized to combine low dielectric losses with high mechanical strength. Steatite ceramics with a power factor in the order of .001 at 10 mc are produced commercially. While it is possible to reduce the power factor further, such Steatite bodies have certain limitations; they have a short firing range over which they may be vitrified without warping and over-firing. Crystal growth also has to be controlled closely by proper compounding and firing, to maintain good mechanical properties and to keep dielectric losses within specified limits.

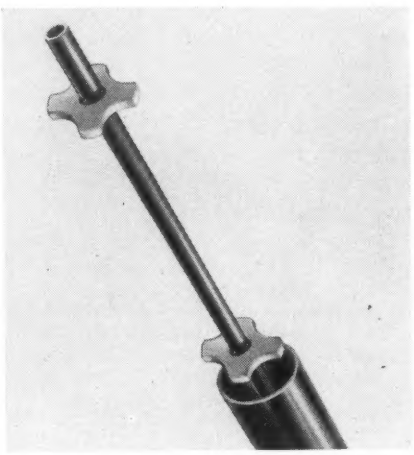


Here, and at the right, are shown examples of some of the many applications for the newly developed dielectric AlSiMag 243, a Forsterite body

It seemed advisable therefore to develop a ceramic material with the same, or better, low loss characteristics than special Steatites and at the same time reduce the manufacturing limitations of such bodies.

In 1942 Zircon porcelain bodies with excellent physical and dielectric characteristics were developed and seemed to fill this need. However, zircon porcelain is about one-third heavier than Steatite. Its dielectric constant is high, about 9, compared with 6 for Steatite bodies.

Considering these various factors, a new ceramic composition has been developed by American Lava Corp. which combines low dielectric constant, low power factor with good mechanical strength and which can be manufactured by standard Steatite processes. This new ceramic material has been given the designation AlSiMag 243.



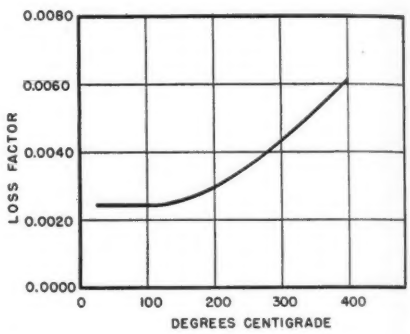


Fig. 1—Loss factor (power factor X dielectric constant) at various temperatures

This new material may be called a "Forsterite" body, because its main mineral constitutent is the magnesium ortho silicate ($2MgO.SiO_2$). Forsterite is by no means a new crystalline compound used in ceramics. Its high melting point (1890° C.) makes this material well suited for the manufacture of refractories for industrial purposes. These, of course, are not vitrified, but physically speaking, have more or less the same characteristics and general properties as refractory brick. They cannot be used as high frequency electrical insulators.

In the developement of AlSiMag 243 preliminary samples of Forsterite were obtained from the U. S. Bureau of Mines Electrotechnical Laboratory, Norris, Tenn., where a pure type of this compound was prepared from the mineral olivine. The product was finely ground, mixed with small amounts of ceramic fluxes, and it was possible to produce a vitreous ceramic product at a firing temperature of about 1400° C. Not only was the loss factor of such bodies lower than that

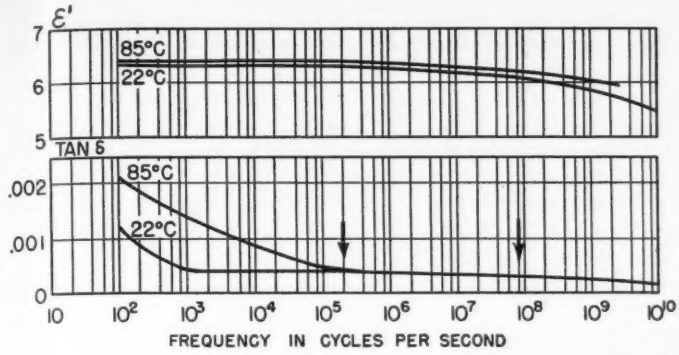


Fig. 2—Dielectric constant and power factor of AlSiMag 243 at various frequencies

of commercial Steatite bodies, but also it was found that it did not change materially after exposure to varying degrees of temperature and humidity. The mechanical strength of the material was quite satisfactory and it seemed to have a remarkaby wide firing range.

After much experimentation, the final body formulation, which combines excellent dielectric characteristics and good mechanical properties was found. It is of such composition that it can be produced commercially.

The mechanical and electrical properties of this material are listed in the table, together with those of the Steatite bodies AlSiMag 35 and 196 and Zircon porcelain. The values for Zircon porcelain are taken from a paper by Ralston Russell, Jr., which appeared in the Westinghouse Engineer, May 1946.

AlSiMag 35 is an all-purpose Steatite ceramic, and AlSiMag 196 a low loss Steatite ceramic. It can be seen that the good mechanical strength of the Steatite bodies has been retained in AlSiMag 243. The power factor of the material in the frequency range of 1 mc to 100 mc is about one-third that of AlSiMag 196, while the dielectric constant of the material remains at the low value of 6.1-6.2. It has to be borne in mind that these quoted figures were obtained after the test specimens have been immersed in water for 48 hours. This shows that the material is not only impervious to penetration of water, but also that it has such surface characteristics that a moisture film does not adhere tenaciously to the surface, as is the case for some insulating materials.

AlSiMag 243 retains its excellent dielectric properties at elevated temperatures. Fig. 1 shows the change of power factor with temperature. It can be noted that no change occurs between room temperature and 100°C. Volume resistivity remains high, and the Te value of the material (the temperature at which one centimeter cube has a resistance of one megohm) is above 1000°C.

Change of dielectric constant and

(*Continued on page* 130)

ITEM		A.S.T.M. Test Number	UNIT	Dense Steatite Materials, Chiefly Clinoenstatite Crystals ($MgO\text{-}SiO_2$) AlSiMag 35	AlSiMag 196	Forsterite ($2MgO\text{-}SiO_2$) AlSiMag 243	Zircon Porcelain Westinghouse
Specific Gravity		—		2.5	2.6	2.8	3.68
Density		—	Lbs./cu.in.	.090	.094	.101	.122
Volume		—	Cu. in per lb.	11.11	10.64	9.91	8.20
Water Absorption		D116-42(A)	%	0-.05	0-.05	0-.05	0.0
Color		—	—	White	White	Buff	White
Softening Temperature		C24-35	°C	1,450	1,440	1,440	—
			°F	2,642	2,624	2,624	—
Resistance to heat (safe limit for Constant Temp.)		—	°C	1,000	1,000	1,000	1,050
			°F	1,832	1,832	1,832	1,922
Hardness		—	Mohs' Scale	7.5	7.5	7.5	8.0
Linear Coefficient of Thermal Expansion	25-100°C	—	Per °C	6.9×10^{-6}	7.3×10^{-6}	9.1×10^{-6}	—
	25-700°C	—		8.7×10^{-6}	8.6×10^{-6}	10.6×10^{-6}	4.9×10^{-6}
Tensile Strength		D116-42	Lbs. per sq. in.	8,500	10,000	10,000	12,700
Compressive Strength		D667-42T	Lbs. per sq. in.	75,000	85,000	85,000	90,000
Flexural Strength		D667-42T	Lbs. per sq. in.	18,000	20,000	20,000	25,000
Resistance to Impact (½" rod)		Charpy D667-42T	Inch-Lbs.	4.5	5	4.0	—
Thermal Conductivity (Approx. Values)		—	g. cal. x cm. thick / $cm.^2$ x sec. x deg. C	.006	.006	.008	.0117
Dielectric Strength (step 60 cycles) Test discs ¼" thick		D667-42T	Volts per mil	225	240	240	290
Volume Resistivity at Various Temperatures	25°C 77°F	—	Ohms per centimeter cube	10^{14}	10^{14}	10^{14}	10^{13}
	100°C 212°F			2.1×10^{12}	1.0×10^{13}	5.0×10^{13}	—
	300°C 572°F			6.0×10^{7}	1.8×10^{9}	7.0×10^{11}	8.0×10^{9}
	500°C 932°F			3.2×10^{5}	9.0×10^{6}	1.2×10^{10}	7.0×10^{7}
	700°C 1292°F			2.3×10^{4}	5.0×10^{5}	1.0×10^{8}	5.0×10^{6}
	900°C 1652°F			7.0×10^{3}	7.0×10^{4}	3.0×10^{6}	—
Te Value		—	°C	440	640	>1,000	> 700
			°F	824	1,184	>1,832	>1,292
Dielectric Constant(*)	60 Cycles	D667-42T	—	6.1	5.9	6.3	—
	1 MC			5.9	5.8	6.2	9.2
	10 MC			5.8	5.7	6.2	—
	100 MC			5.7	5.6	6.1	—
Power Factor(*)	60 Cycles	D667-42T	—	.015	.0022	.0014	—
	1 MC			.0035	.0021	.0004	.0010-.0014
	10 MC			.0030	.0015	.0003	—
	100 MC			.0028	.0014	.0003	—
Loss Factor(*)	60 Cycles	D667-42T	—	.09	.013	.0088	—
	1 MC			.021	.012	.0025	—
	10 MC			.017	.008	.0019	.009-.013
	100 MC			.016	.008	.0018	—
Capacity Change Per °C		—	Parts per million	—160	—160	—130	—

(*) Measured wet, after immersion in water for 48 hours (JAN-1-10).

News of the Industry

FCC Studies Citizen's Radio Service at 460-470 mc

Seeking to speed the launching of the Citizens' Radiocommunication Service, which would provide short-range private radiotelephone service to a variety of users, the FCC recently issued a listing of technical requirements for equipment to be used in the new communications field, designed to establish a uniform regulatory procedure whereby specific types of transmitting equipment constructed by manufacturers for use in the service would be formally approved by the Commission.

The new service, to operate in the 460-470 mc will operate under three categories of stations on different frequencies within the 460-470 mc band.

Following conformity to technical requirements laid down by the Commission, formal written application for type approval of transmitting equipment intended for ultimate general distribution may be made by a manufacturer to the Commission. The manufacturer would then send a typical production model of his equipment to the Commission's Laurel, Md., laboratories for testing. A complete report on the equipment would then be submitted to the manufacurer, noting approval or rejection of the equipment for the new service.

Status of TV Stations

According to statistics released by the Federal Communications Commission, the United States currently has six commercial television stations rendering broadcast service. Altogether, there is a total of 78 licensees, construction permits, and pending applications. These include 31 outstanding construction permits authorizing new stations; 14 applications designated for hearing and awaiting decision; 11 applications pending disposition of hearing; 10 applications pending receipt of information requested by the Commission; and 6 applications in course of being processed.

Helicopter Radiophone

First commercial installation of personal radiophone is this Bendix equipment in new Sikorsky two-place helicopter ship

2450 MC Allocated for Industrial Uses

The frequency of 2450 mc was made immediately available by the FCC as the year ended for electronic medical diathermy and industrial heating equipment. Recognizing the commercial and public benefits in harnessing electronics to medical, household and commercial use, the FCC stated that, rather than wait for the promulgation of regulations and engineering standards it had decided to allocate this frequency with all emissions from the industrial, medical and scientific electronic apparatus confined within the band of 2400 to 2500 mc. This obviates the necessity for licensing such apparatus.

UN Broadcasting System Estimated at Six Billion

A detailed plan for United Nations' international broadcasting and tele-communications activities, urging the expenditure of nearly $6 million for equipment within three years but specifically providing that the UN facilities "will refrain from entering the point-to-point general service field in competition with member nations' commercial systems," has been distributed to General Assembly delegates for study. The plan will be voted on at the next meeting of the Assembly in September, 1947.

The program, product of the three-man Advisory Committee chairmaned by Brig. Gen. Frank E. Stoner, U. S. Assistant Chief Signal Officer, was primarily devoted to the short-wave broadcast activities of the UN and their expanded dissemination to the member nations through a main station in the U. S. and two relay stations, fed into the broadcast networks of the individual nations if necessary. At the same time, simultaneous record transmission of the broadcast material would provide printed copies of the information and discussions for local press and public use.

The group recommended the expenditures of $2,994,000 for facilities at UN General Headquarters, $1,887,000 for facilities at the main European field office, primarily for a relay station, $526,000 for the broadcast relay station to serve Eastern Asia and Pacific areas, $335,000 for facilities at a Latin

(*Continued on page* 120)

CONVENTIONS AND MEETINGS AHEAD

American Society for Testing Materials—Spring Meeting—Benjamin Franklin Hotel, Philadelphia, Pa., February 24-28. **Annual (15th) Meeting**—Chalfonte-Haddon Hall, Atlantic City, June 16-20.

Institute of Radio Engineers—Annual Meeting (Commodore Hotel) and Show (Grand Central Palace), New York, March 3-7.

Midwest Power Conference—Palmer House, Chicago; sponsored by Illinois Institute of Technology; March 31-April 2.

Institute of Radio Engineers, North Atlantic Region—Radio Engineering meeting, Hotel Continental, Cambridge, Mass. John M. Clayton, General Radio Co., Cambridge. May 3.

Society of the Plastics Industry—Annual Convention (Stevens Hotel) and National Plastics Exposition (Coliseum), Chicago, May 5-11.

1947 Radio Parts and Electronic Equipment Conference and Show—Stevens Hotel, Chicago, May 13-16.

Second National Instrument Conference and Exhibit—Hotel Stevens, Chicago, September 8-12.

WASHINGTON

★ ★ ★ **Latest Electronic News Developments Summarized by *Tele-Tech*'s Washington Bureau** ★ ★ ★

SHORT-WAVE BROADCASTING PLANS OF UNITED NATIONS—A program calling for expenditure of $6 million for equipment during the next three years for a network of short-wave broadcasting stations to serve the world's estimated listening audience of 303,975,000 (or one-sixth of globe's population), has been presented to United Nations by Brigadier General Frank E. Stoner, Assistant Chief Signal Officer of the U. S. Army, who headed a special UN tele-communications committee. It will be voted upon by UN General Assembly in September. The plan calls for a main short-wave station in the United States and relay stations in Europe, South America and Far East. Besides short-wave broadcasts, UN programs are to be distributed in domestic networks of various nations of the world. In addition to broadcast programs, the UN network also will carry on carrier channels textual material on programs for press dissemination and other press material of the organization, using an invention and radioprinter system of Globe Wireless Vice President Walter Lemmon, who organized the well-known short-wave station WRUL at Boston.

TELEVISION DECISION "TOUGH NUT" FOR COMMISSION—Probably the most difficult problem in the entire history of the FCC is the determination of the Columbia Broadcasting System's proposal to have the "upstairs" television channels of 480 to 920 mc opened up for commercial very high definition and color video programs. The difficult problem, the subject of hearings in December, was winding up in the hearing stage during the last week of January and in early February and featured CBS's color television system in several days' demonstrations in New York. The FCC endeavored in these final hearings to determine whether flicker occurred with any marring effects on the CBS sequential system of color video and if the pictures were bright enough for home viewing. In the previous CBS demonstrations the Commissioners and leading staff officials had been substantially impressed with the CBS showings and the testimony of CBS President Stanton, Dr. Goldmark and other CBS executives in the December hearings was rated as most worthwhile and comprehensive.

DILEMMA IS POSED—The FCC Commissioners frankly are concerned over the issue. They do not want to throw black-and-white TV for a loss through the adoption of color video commercial standards before the latter service is fully ready. Now that the public imagination has been aroused more than ever before in TV history with such programs as outstanding football games, the opening of Congress and President Truman's "State of the Union" message, the Commission feels the new art must be given all encouragement possible.

MORE FIELD TESTING NEEDED — Interestingly enough, although the FCC has no control in this field, the programs and type of presentations are now being considered by many followers of TV as more important than whether video should be black-and-white or color. Then, too, the FCC is weighing carefully the views of the majority of the RTPB Television Panel, voiced by Philco Vice President David B. Smith, and of the leading RCA experts, headed by RCA Laboratories Vice President C. B. Jolliffe, who caution that more field testing and developmental work is needed to get all the "bugs" out of the color television system and to determine whether the system should be "sequential" or "simultaneous". In addition, there is no definite indication that the color video transmitters and receivers are readily available for full-scale production.

EXPECT 4 MILLION FM SETS—Manufacturers expect the production of more than four million FM sets during 1947 and, because of quality of reception and performance, the manufacturing company executives hope the cabinet shortage will become alleviated so the vast majority of the sets will be of the console type, and a smaller proportion of the output will be table models. Proponents of FM broadcasting, too, feel that FM set sales will be boosted because of the prevailing situation that postwar AM replacement receiver sales have been rather disappointing, resulting in many table model types being virtually dumped on the Xmas market. FM sets will be like a new type automobile and will arouse public demand, it is believed.

WOMAN COMMISSIONER?—With the selection of a Republican for the FCC vacancy—Miss Marion E. Martin, former Assistant Chairman of the Republican National Committee and the first woman ever named to the Commission—the possibilities of a sweeping investigation of that agency by either the Senate or the House are swept into the discard.

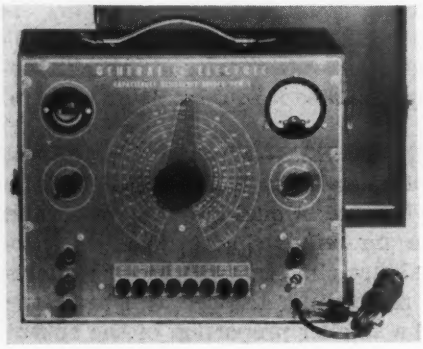
National Press Building
Washington, D. C.

ROLAND C. DAVIES
Washington Editor

New Lab and Test Equipment

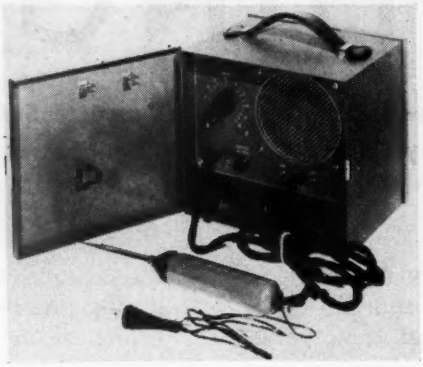
HIGH FREQUENCY VOLTMETER

By equipping the high frequency electronic voltmeter Model 32 with an rf probe having an input capacity of ¾ mmfd, the range of measurement has been extended to 500 mc. The instrument measures rf voltage from 0.3 to 300 volts in five ranges with better than 5% of full scale accuracy on all ranges and sinusoidal voltages. Frequency range is 500 kc to 500 mc. The unit uses a 6AL5 tube in the probe, two 6J6's and a 6X5GT rectifier tube. It operates on 115 volts, 60 cycles, ac and consumes 30 watts.—*Alfred W. Barber Laboratories, 34-14 Francis Lewis Blvd., Flushing, N. Y.*



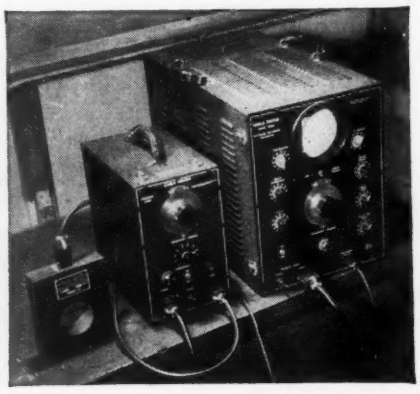
RESISTANCE-CAPACITY BRIDGE

Designed primarily for production testing of a wide range of capacity and resistance the portable condenser-resistor bridge type YCW-1 features push-button switching, may also be used for measuring the turns-ratio of transformers. Capacity may be measured from 5 mmfd to 200 mfd in three ranges, and resistance from 5 ohms to 20 megohms in two ranges. Accuracy of the Wien bridge is ± 1% for capacitance and ± 2% for resistance, balance being indicated by a magic eye tube. The bridge also measures insulation resistance, leakage current and power factor of capacitors. The unit weighs 10 lb. and operates directly from 115 volt, 50-60 cycle, ac.—*Specialty Div., G-E Electronics Dept., Wolf St. Plant, Syracuse, N. Y.*



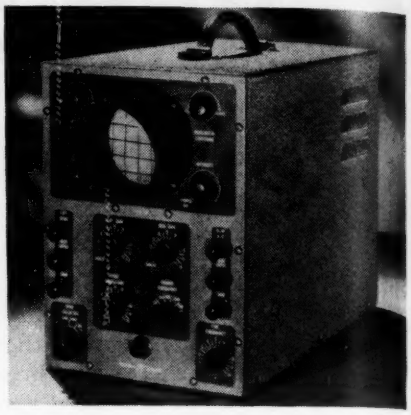
SIGNAL TRACER

Sensitive and hum free signal tracing can be performed with this portable battery-operated signal tracer which, housed in a gray steel case, weighs only 4 lb. 10 oz. Low drain tubes are used for long battery life. For battery protection the case cannot be closed with the power switch on. A long probe and lead permits getting at hard-to-reach spots. Automobile radio receivers may be checked without removing the set from the car.—*Special Products Co., Silver Spring, Md.*



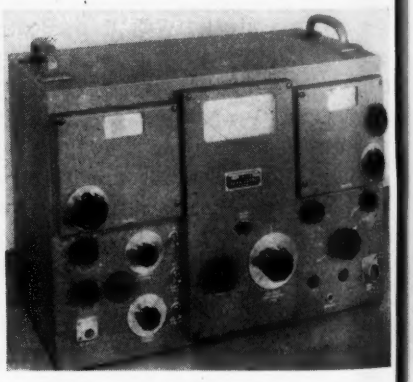
CABLE TESTER

Operating on the same core-loss principle as the Cyclograph, this instrument for testing stress in wire ropes is portable, comprising a main oscillograph unit and a separate oscillator operating on standard 110 volt, 60 cycle, ac power. The test coil connected to the oscillator is located near the wire rope under test. In addition to instantaneous reading of core loss with increase in stress, on the oscilloscope screen, a permanent recording means is provided by an Easterline-Angus 1 mil. recording milliammeter. A 110-volt relay supplied with the equipment can be set to operate a warning signal at a specified limit, if properties of rope change more than an allowable amount. A continuing change in recorder reading at any point in a rope indicates the failure point.—*Allen B. DuMont Labs., Inc., Passaic, N. J.*



CATHODE RAY OSCILLOSCOPE

Featuring portability, low cost, and practical design for servicing and general applications, the type 131 oscilloscope weighs only 18 lbs. and has 6 tubes including a 3AP1 3-in. cathode ray tube designed for 650 volt deflection plate operation. A signal frequency range from 15 to 40,000 cycles is provided with a five range selection control and fine frequency control. The sweep circuit uses a type 884 gas triode oscillator. The instrument is rated at 40 watt input at 105/125 volt, 50-60 cycle, ac.—*Sylvania Electric Products Inc., 500 Fifth Ave., New York 18.*



FIELD INTENSITY METER

For use in the television and FM bands from 50 to 220 mc model 106 field intensity meter is a direct-reading instrument in terms of microvolts per meter without use of charts, curves or calculations over a range of 5 microvolts to 10 volts. The receiver has one stage of amplification at the signal frequency and features single control tuning. A built-in calibrating oscillator provides a standard signal source. A vibrator power supply is incorporated in the instrument. Selectivity is variable from flat-top response with 200 kc bandwidth and sharp cutoff to a highly selective condition.—*Clarke Instrument Corp., 910 King St., Silver Spring, Md.*

LOOKING FOR A HIGH PRECISION RECTIFIER?

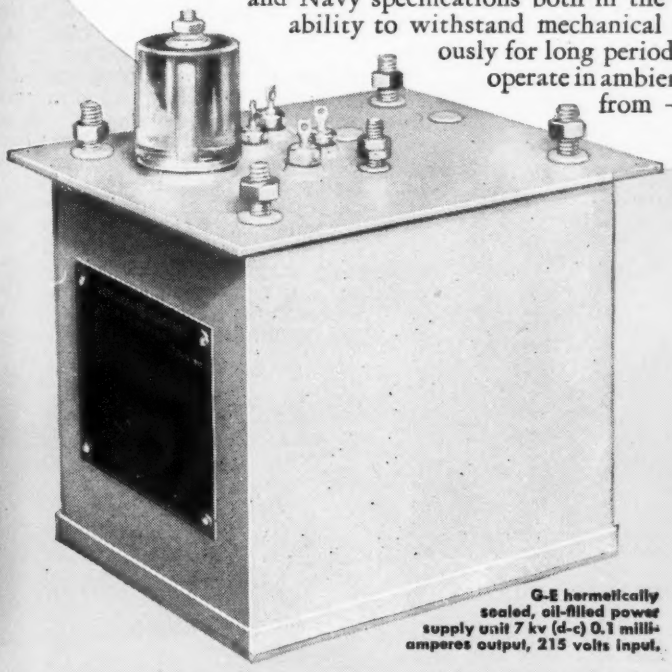
This one has Regulation Accuracy to
3.5% of 0.1 *Milliamperes Load*

LOW-CURRENT, HIGH-VOLTAGE D-C POWER SUPPLY IS COMPACT, LIGHT IN WEIGHT—HAS PREVIOUSLY UNOBTAINABLE FEATURES

These new small, light-weight a-c to d-c power supply units are especially built for precision work. They have a number of highly desirable features which make them suitable for supplying the high potential necessary for cathode-ray tubes, television camera tubes and radar indicator scopes, electron microscopes, and other jobs where unusually low regulation, light weight, and small size are primary considerations.

The unit shown here (Cat. 8317502) will supply 7 kv at 0.1 milliamperes d-c output. The regulation does not exceed 3.5% per 0.1 milliamperes load, and 15% at 0.5 milliamperes maximum load. The ripple on the output voltage is less than 1%. This unit is manufactured for 215 volts, 10,000 cycles, a-c input. An additional pair of terminals is provided to supply 45 volts a-c when 215 volts are applied to the input terminal.

This completely self-contained hermetically sealed rectifier will meet Army and Navy specifications both in the matter of design, and as to its ability to withstand mechanical shock and operate continuously for long periods of time. It is designed to operate in ambient temperatures ranging from −40 C to +60 C.



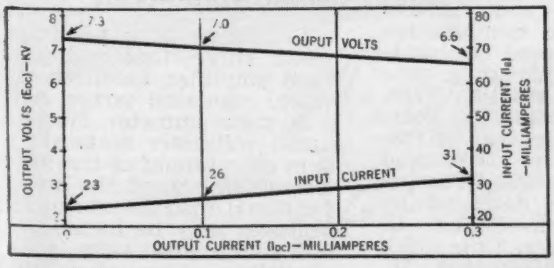
G-E hermetically sealed, oil-filled power supply unit 7 kv (d-c) 0.1 milliamperes output, 215 volts input.

Has these Features

- **Precision stability**
- **Light weight (8 lb)**
- **Small size (6 by 6 by 7 in.)**
- **Selenium elements**
- **Only one high-voltage terminal exposed**
- **Filter has low energy storage**
- **Readily mounted**
- **Oil filled for strength**
- **Hermetically sealed**
- **Can be used as tank circuit of an audio oscillator***

*An unusual feature of this unit is that it may be used as the tank circuit of an audio oscillator. The input terminals are connected to the plate circuit. The 45-volt output terminals are connected as the grid feed back. The oscillator tube normally used is a 6V6. The operating frequency is 10,000 cycles.

INPUT CURRENT TO OSCILLATOR AND OUTPUT VOLTAGE VS. OUTPUT CURRENT TO LOAD



GENERAL ELECTRIC 401-44-6155

GENERAL ELECTRIC COMPANY *Apparatus Dept.,* Section A401-44, Schenectady 5, N. Y.

Gentlemen:

1. *Please submit quotation on.....Cat. No. 8317502 rectifiers, as illustrated.*
2. *Please submit quotation on.....rectifier units, similar to Cat. No. 8317502, designed to meet the attached specifications.*

Name.....

Organization.....

Address.....

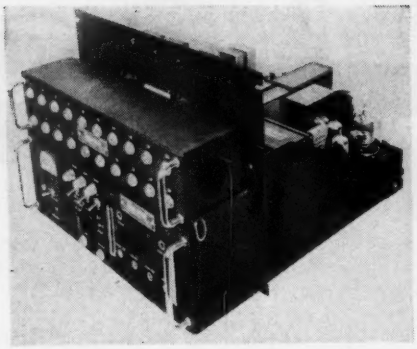
City.....State.....

VOLT-OHM-CAPACITY METER

Direct-reading measurements of capacitance from 50 mmfd to 2,000 mfd and VTVM measurements of ac voltage up to 6,000 are possible with model 668 electronic multitester, which comprises an ac-dc vacuum - tube volt - ohm - capacity meter. The frequency range of the instrument for signal and output voltages is from 10 to 250,000 cps. The resistance range extends from 0.1 ohm to 1,000 megohms in seven ranges. The unit is stabilized against line voltage fluctuations, has mechanical and electrical zero adjustment, and a full scale accuracy of 2%. It operates on standard 110-130 volt, 50-60 cycle, ac supply.—*Radio City Products Co., Inc., 127 W. 26th St., New York City.*

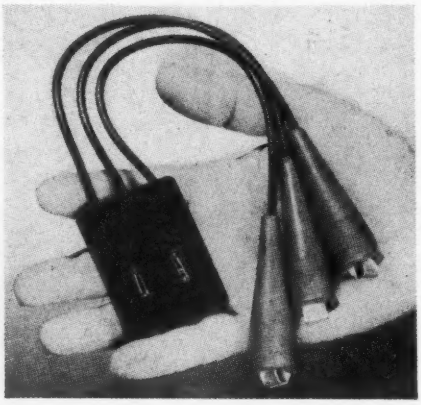
VACUUM TUBE TEST SET

Operator fatigue is reduced and personal errors are eliminated by this vacuum tube bridge characteristic test set which measures mutual conductance, plate resistance, amplification factor and all static characteristics of electronic tubes. Operating from a 1500 watt, 220 volt, three phase, 60 cycle, ac source the unit provides a 0-600 volt, 100 ma supply for plate and screen grid, 0-300 volt, 100 ma for auxiliary and heater cathode, 0-300 volt, 400 ma for emission, and 0-100 volt, 2 ma, for bias. A variety of ac and dc filament supplies are also provided for.—*Sylvania Electric Products, Inc., 500 Fifth Ave., New York 18.*



TUBE LIFE TEST EQUIPMENT

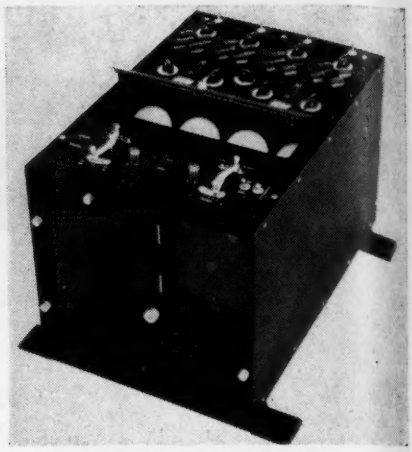
Suitable for life testing receiver type tubes under pulsed operating conditions this apparatus consists basically of a control panel, power unit, pulse modulator and test rack. The power unit provides all potentials normally required for receiver type tube testing up to 500 volts plate voltage at 250 ma current. The modulator delivers a positive pulse adjustable from 50 to 350 volts to the grids of the tubes under test. A pulse current of 10 amps. at .01 duty cycle is provided. Pulse width is variable from 1 to 25 microseconds and repetition rate is adjustable from 500 to 2500 times per second. Up to ten tubes may be mounted in the tube rack and the entire assembly mounts in a standard 19 in. wide relay rack.—*Chatham Electronics, 475 Washington St., Newark 2, N. J.*



PHASE & CONTINUITY INDICATOR

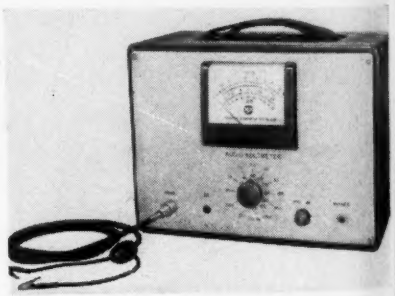
Engineered to readily distinguish between ac and dc, positive and negative, 220 and 110 volts ac or dc, direction and phase rotation, the Polyvoltester will also identify all wires, high phase and lighting phase, in a 4-wire combination system, and can be used for locating blown fuses and other continuity tests. Phase rotation "left" or phase rotation "right" is indicated. Accurate indication at frequencies considerably above and below 60 cycles is possible. The instrument cannot be damaged by improper connection.—*Robert C. Rindfleish & Associates, Suite 219C, The Engineering Bldg., 205 W. Wacker Dr., Chicago 6, Ill.*

NEW COMMUNICATIONS COMPONENTS—PAGE 104



CATHODE-RAY RECORDER

Originally designed to produce a permanent record of transients encountered in shock tests of aircraft structures, the CR43A cathode-ray recorder (because of its wide frequency range and rugged construction) is suitable for laboratory and field studies of high speed transient and steady state phenomena occurring in strain, vibration and pressure measurements. The instrument has four recording channels, each consisting of one-stage balanced amplifier coupled to a three-in. short persistence blue screen cathode ray tube. Two or four channels are photographed by means of a built-in 35 mm camera operable at four speeds. A fork-controlled discharge tube provides 100 time marks per second. Sensitivity with amplification is 1 volt rms per in. at tube screen, and response is flat from zero to 40 kc direct or with amplifiers. The unit operates on 110 volts, 60 cycle, ac and consumes 450 watts during recording.—*Heiland Research Corp., 130 E. 5th Ave., Denver, Colo.*



AUDIO VOLTMETER

Consisting of a precision attenuator, three-stage high-gain stabilized amplifier, balanced diode rectifier, regulated power supply and a dc microammeter, model WV-73A audio voltmeter measures ac voltages over ranges of frequencies and amplitude beyond the limit of conventional instruments of this type. Voltages may be measured from 1 millivolt to 1000 volts in 11 ranges regardless of waveform distortion, average value of the full waveform being utilized by the balanced diode. Frequency range of the meter is 20 cycles to 20 kc.—*RCA Victor Div., Radio Corp. of America, Camden, N. J.*

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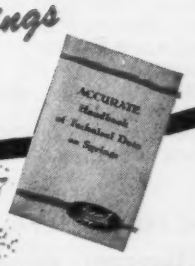
means lower ultimate cost FOR YOU!

Ordinarily you don't speak of the uniformity of a batch of springs in the same breath with cost. But the two are really inseparable . . . variations in the size and shape of springs can cause the loss of dollars worth of assembly time . . . variations in load characteristics can result in unsatisfactory operation of the finished p.oduct.

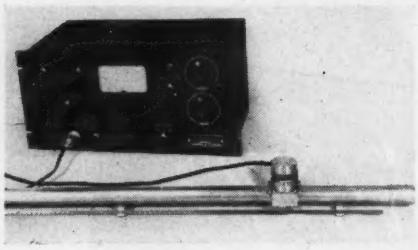
Here at Accurate you'll find skilled springmakers and practical, experienced engineers . . . people who realize the importance of uniformity to you. Why not make it a point to discuss your spring problems with us. **ACCURATE SPRING MFG. CO., 3808 W. Lake Street, Chicago 24, Illinois**

Load testing is one of several controls exercised at Accurate.

Springs Accurate Springs Wire Forms • Stampings

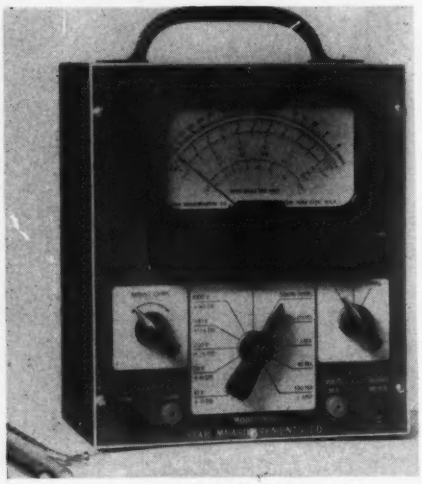


Send for your copy of the new Accurate Spring Handbook. It's full of data and formulae which you will find useful. No obligation of course.



VHF WATTMETER

Laboratory measurements of power, impedance, standing wave ratio, and approximate determination of frequency are conveniently performed with the model 60 vhf wattmeter which is operable over the frequency range from 70 mc to 400 mc. The instrument consists of a precision slotted line with a characteristic impedance of 50 ohms fitted with a sliding probe, and a meter and control panel equipped with electronic voltage regulator and constant voltage transformer. Power may be read directly from .25 to 150 watts in 4 ranges; SWR values are indicated from 1 to 10 as well as complex impedances within this range and resistive impedances from 5 to 500 ohms. The instrument has 9 tubes and is for operation on 105-125 volt, 60 cycle, ac.—*The Rollin Co., 2070 N. Fair Oaks Ave., Pasadena 3, Cal.*

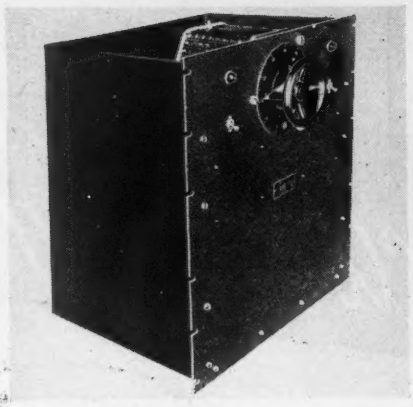


VOLT-OHM-MILLIAMMETER

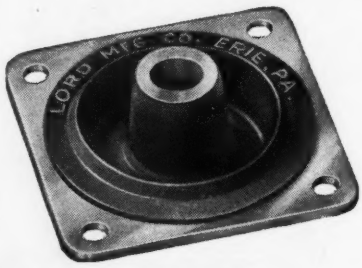
An economically priced volt-ohm-milliammeter provides 27 separate ranges of measurement using a 4½ in., 400 microamp. Marion meter in a metal cabinet. Sensitivity of 1000 ohms per volt is provided on five ac and dc voltage ranges up to 1000 volts. Current may be measured up to 1 ampere in four ranges and resistance up to 5 megohms in three ranges. Five db and output meter ranges to 54 db and 1000 volts respectively are included.—*Star Measurements Co., 442 E. 166th St., New York 56.*

DC POWER SUPPLY

Designed for continuous duty, small regulation and easily adjusted output voltage from 0-3,000 volts at .5 ampere maximum the Seco dc power supply operates from



a 115 volt, 50-60 cycle, ac source. The power supply uses a full wave bridge rectifier consisting of four type 866/866A tubes. A time delay relay allows adequate heating of filaments before supplying high voltage. Ripple at rated voltage is .1% and regulation is 10% maximum for a change in load current from 0-.5 amperes for max. output voltage.—*The Superior Electric Co., Bristol, Conn.*

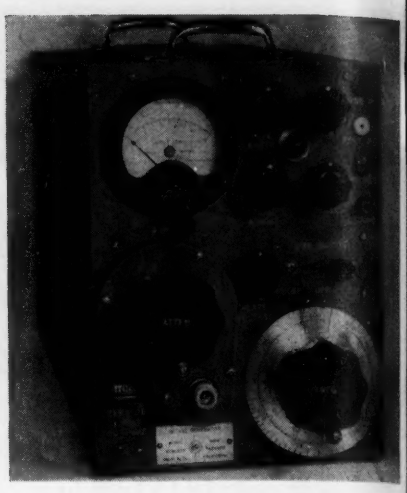


VIBRATION ISOLATOR

Vibrations are isolated regardless of the direction of the disturbing force by Multiplane mountings which by the principle of rubber-in-shear secure equal softness in all planes. The mountings are recommended for the protection of equipment exposed to vibrations of indeterminate nature, and have been successfully used for electronic equipment, instrument panels, fans, blowers, airconditioners, etc. —*Lord Mfg. Co., Erie, Pa.*

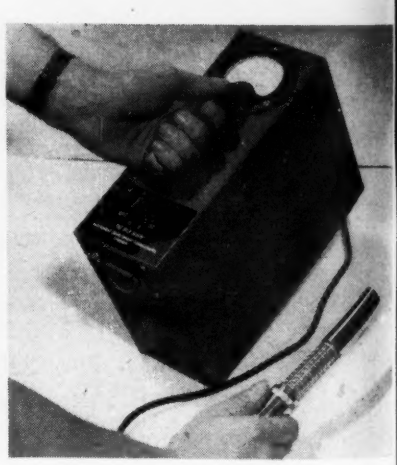
FREQUENCY METER

Designed to measure frequencies in the audio and supersonic spectrum the Daven type 838 frequency meter finds application in electrical, radio, acoustics measurements, recording and telephone laboratories. Seven overlapping ranges are provided for direct frequency determination between 20 and 100,000 cps with an accuracy of ±2% of the top frequency in each range. Frequency indication is substantially independent of variations in input voltage between 0.5 and 150 volts rms. The instrument is for rack mounting.—*Daven Co., 191 Central Ave., Newark 4, N. J.*



UHF SIGNAL GENERATOR

Designed to provide a laboratory standard for measurements in the range 500 to 1350 mc model 610-A uhf signal generator will supply a calibrated voltage throughout the range from 0.1 microvolt to 0.1 volt. The rf output may be continuous, amplitude modulated or pulsed. The signal is fed through a 50 ohm coaxial line terminated with type N fittings. Pulse length can be varied from 2 to 50 microseconds and the repetition rate from 60 to 3,000 cycles per sec. The instrument operates on 115 volts, 50 to 60 cycle, ac and consumes 100 watts.—*Hewlett-Packard Co., 395 Page Mill Road, Palo Alto, Cal.*



RADIOACTIVITY METER

For radioactive ore surveys and for locating radioactive products, which may be health hazards model 2610 portable beta-gamma count rate meter has three ranges from 0.2 to 20 milliroentgens per hour full scale. The meter distinguishes between beta and gamma rays by means of an adjustable shield in the window of a detachable probe, which holds the Geiger-Mueller tube. The instrument is battery operated, weighs 10 lb., and is equipped with a double receiver headset.—*Instrument Development Laboratories, 817 E. 55 St., Chicago 15, Ill.*

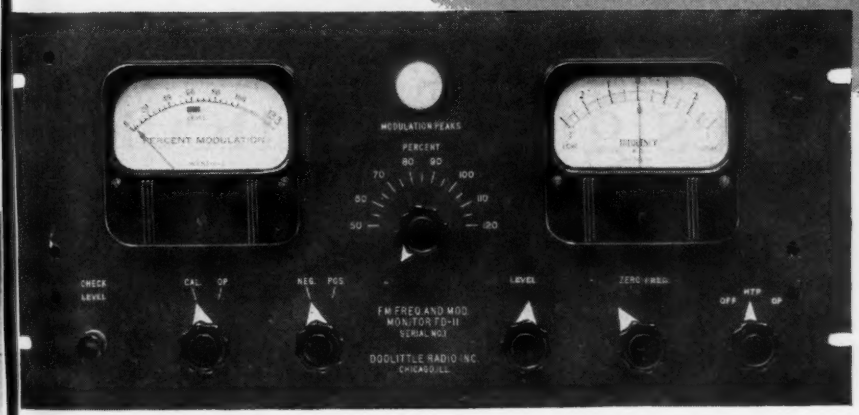
Another New Member of the Famous Monitor Line

by Doolittle

New FM BROADCAST FREQUENCY *and* MODULATION MONITOR FD-11

FOR THE BROADCAST
88-108 mc. Band

DIRECT READING



MEETS FCC REQUIREMENTS The new FD-11 combines a frequency meter and modulation indicator in one convenient unit. No charts or complicated adjustments are needed. *Direct reading* of center frequency deviation with an accuracy of better than .0003%. *Direct reading* up to 133% modulation for either positive or negative peaks with an accuracy of ±5% at any reading. Can be calibrated with WWV directly with use of an external receiver of normal sensitivity. Many other features assure consistent accuracy and rugged, long life. Operates on 110 V.A.C. 60 cycle. For rack mounting. Panel size 8¾" x 19". Write, wire, or phone RADcliffe 4100 for full information.

NOTE THESE ADVANTAGES

1. No tuned IF circuits
2. No tuned discriminator
3. Provides for checking frequency of Heterodyne crystal
4. 100 KC osc and 10 KC multivibrator which may be used for other frequency measurements
5. Positive indication of Frequency Meter operation
6. Rack or table cabinet mounting
7. All components on one chassis
8. Simultaneous Local and Remote indication of both Frequency Deviation and Modulation Percentage (available at extra charge)
9. Overall distortion less than 0.25% RMS
10. Audio output impedance 500 ohm or higher

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RADIO, INC.

Builders of Precision Communication Equipment

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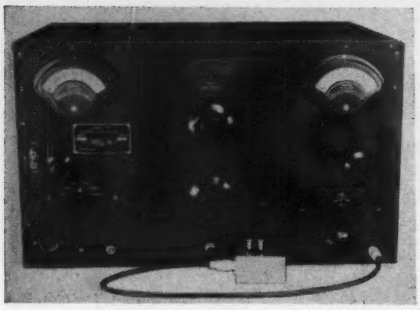
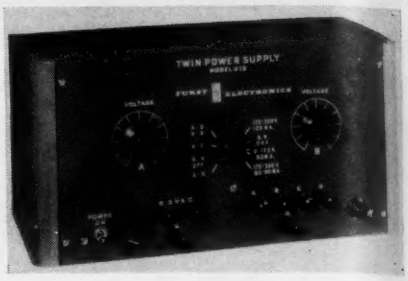


SIGNAL GENERATOR

Up to 10 watts of rf power, sufficient to drive an antenna, or the microvolts needed to measure receiver sensitivity are provided by model 20 power type standard signal generator which has a 160 db attenuation range. Eight bandspread tuning ranges cover 85 kc to 40 mc in a MOPA circuit using a 6C4 oscillator and 829-B amplifier. Calibrated low impedance current output adjustable from .1 to 1 amp. is provided as well as calibrated output voltage from .1 microvolt to 15 volts across 20 ohms. Up to 80% modulation is available at four fixed frequencies from 100 to 3,000 cps. The instrument will operate on 105-130 volts, 60 cycle, ac.—*The Rollin Co.*, 2070 *N. Fair Oaks Ave., Pasadena* 3, *Calif.*

VACUUM-TUBE VOLTMETER

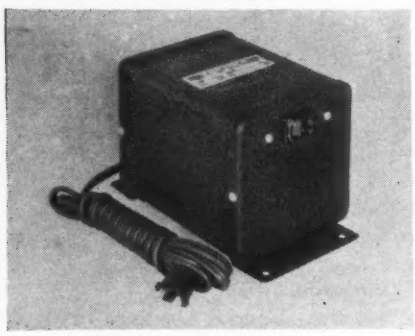
Having high accuracy at 100 mc model 266 vacum tube voltmeter is suitable for the new FM band and hf applications. A zero center switch is provided on dc voltage ranges for discriminator alignment. The rf probe has an input capacitance of approximately 4 mmfd. Ranges include ac or dc volts from 0-5000, 0-500 ma in seven ranges, and 0-10 amps, both on dc only, and seven resistance ranges up to 1000 megohms. Zero adjustment of the instrument remains the same for all ranges.—*Simpson Electric Co.*, 5200-18 *Kinzie St., Chicago* 44.



REGULATED POWER SUPPLY

Model 210 twin power supply has two independent adjustable output voltages of 175 volts each, which vary less than 1% with change in output current from no load to 60 ma rated load, and less than 1 volt with change in line voltage from 105 to 125 volts. Ripple and noise content is less than .025 V rms. A switching arrangement permits connection of outputs in parallel to provide twice normal current or in series for twice the voltage. Output voltage is continuously adjustable either from 0-175 or from 175-350 volts. An unregulated ac voltage of 6.3 at 0-3.5 amps is also available. The unit consumes 150 watts at full load.—*Furst Electronics*, 800 *W. North Ave., Chicago* 22, *Ill.*

Parts for Design Engineers

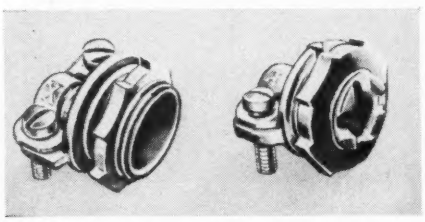


STEP-DOWN TRANSFORMER

Available in sizes of 100, 250, 500, 750, and 1000 watts the Gulow 220 to 110 volt step-down transformer may be supplied as conventional type with open frame construction for use as an integral part of an electrical device. It is also available completely enclosed in a steel case (illustr.) for use as separate unit furnished with a 6 ft. cord. The unit is moisture-sealed.—*The Gulow Corp.*, 99 *Park Place, New York* 7.

CLAMP CONNECTORS

A new series of connectors to provide a single type of fitting capable of terminating any cable or cord in standard ½ in. K.O. is recommended for rubber jacketed cords, armored cable, sheathed cable, and



armored ground wire. Three types of screw clamp connectors are available for ½ in. knockouts. Type C-15 has ½ in. thread for cables with an outside diameter from 3/16 to ½ in. Type C-15S has ⅜ in. thread for use with various sizes of armored cable, and type C-15L, also for armored cable, has a ½ in. thread.—*Gedney Electric Co.*, 1270 *Sixth Ave., New York* 20.

VACUUM CAPACITORS

A series of low loss vacuum capacitors rated at 20,000 volts peak continuous commercial service and 20 amps. peak is available in values of 6, 12, 25, and 50 mmfd. Series 20G2 units have an overall length of 3½ in. and a diameter of 2½ in. Also available is series 20G3 rated at 20 amps., 32,000 volts peak. These units can be used in industrial and communications applications ranging from audio to ultra-high frequencies.—*Gilandung Electronics*, 14 *Union Ave., Campbell, Calif.*

HIGH SPEED DC RELAY

Having an operating time of one millisecond and being bounce free by means of a shock-absorbing mechanism the Millisec relay is suitable for high speed applications including its use as a square wave generator by applying ac to the coil and dc to the contacts. It is made as single pole double throw type for use with resistive loads, and has a contact rating of ½ ampere at 110 volts dc only. Coils are wound for dc either 18 V., 1400 ohms, or 6V., 150 ohms. Life expectancy varies from 22 million operations at ½ amp. to 100 million operations at ¼ amp.—*Stevens-Arnold Co.*, 22 *Elkins St., South Boston, Mass.*

How you will benefit by using the Collins 30K-2

Ground Station Radio Transmitter

The new Collins 30K-2 embodies certain design features that are of outstanding benefit to owners who employ radio communication from point to point, ground to plane, or shore to ship. This 250 watt radio transmitter can be pretuned to any two frequencies between 2.0 mc and 30.0 mc. Relay operation of all r-f circuits, including antenna tuning, provides instantaneous frequency shift.

A speech clipper in the audio circuit raises the effective modulation level and emphasizes the speech sounds that produce intelligibility. The effectiveness is especially noticeable on congested frequency channels and under adverse atmospheric conditions. The 30K-2, when the speech clipper is in operation, has a signal output comparable to that of transmitters with normal modulation and a much larger power output.

Because the r-f carrier is fully utilized, the power consumption of the 30K is comparatively small for the results achieved. Maximum power demand is approximately 1250 watts from a 115 volt a-c single phase power source. Nominal r-f power output is 300 watts on cw or 250 watts on voice transmission.

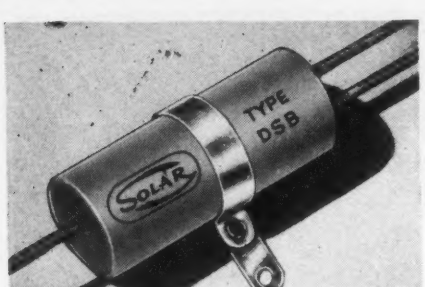
Installation of the 30K-2 is extremely simple. No time consuming, expensive operations are required. Just connect it to a power source and attach the antenna. The transmitter output network will accommodate a wide variety of antennae and transmission lines. A remote control unit is available. For complete details of this new and versatile radio transmitter, write for an illustrated bulletin.

IN RADIO COMMUNICATIONS, IT'S . . .

COLLINS

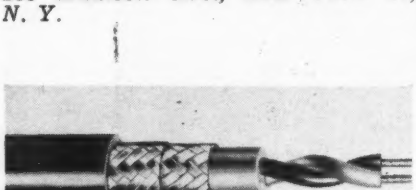
COLLINS RADIO COMPANY, CEDAR RAPIDS, IOWA

11 West 42nd Street, New York 18, N. Y. **458 South Spring Street, Los Angeles 13, California**



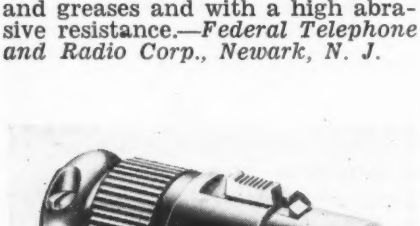
DRY ELECTROLYTIC CAPACITORS

This comprehensive line of type DSB multiple section, high-capacity, dry electrolytic capacitors is furnished with 5 in. insulated leads and integral mounting strap. The cardboard tubular units are protected by a new inner plastic wrap designed to extend their normal life.—*Solar Capacitor Sales Corp., 285 Madison Ave., New York 17, N. Y.*



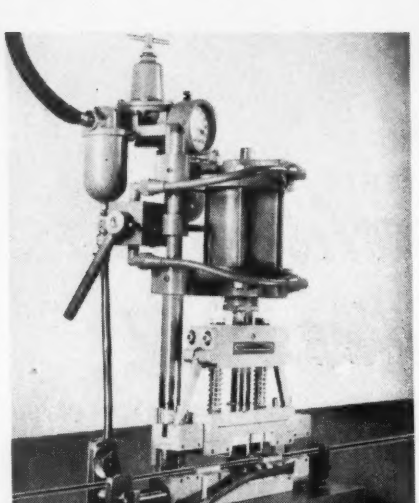
TWISTED CONDUCTOR HF CABLE

For use wherever a balanced transmission line is needed the KT-51 cable is a twisted dual conductor high frequency cable designed to free FM and television receivers from locally induced interference. Characteristic impedance of the cable is 95 ohms with an attenuation of 1.7 db at 30 mc, 3.6 db at 100 mc, and 10 db per 100 ft. at 400 mc. Maximum capacity unbalance is 1%. Use of a non-contaminating jacket assures a durable cable highly resistant to acids, alkalies, oils, and greases and with a high abrasive resistance.—*Federal Telephone and Radio Corp., Newark, N. J.*



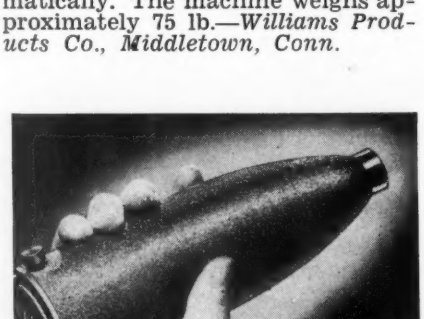
STEEL SHELL PLUGS

To match the standard "XL" zinc receptacles of the "XL" microphone connector series two steel shell plugs have been brought out which are slightly smaller than the corresponding zinc plug types. The integral clamp has a minimum cable entry of ¼ in. and a maximum of 5/16 in. The socket insert assembly carries a latch-lock device. The rugged construction makes the shell adaptable to many uses, provided the 15 amp. rating of the three contacts and minimum flashover voltage of not more than 1500 volts are not exceeded.—*Cannon Electric, 3209 Humboldt St., Los Angeles 31, Cal.*



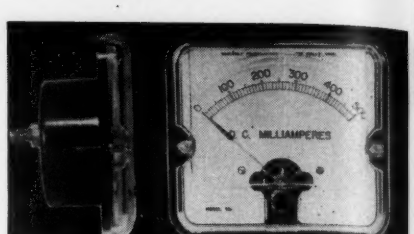
PRODUCTION WIRE STRIPPER

Suitable for production or custom work the Codeco wire stripping machine simultaneously cuts, strips, and slits one, two and three conductor wire up to ½ in. diameter at both ends. Operated by compressed air and equipped with a Bellows-Senacon air motor the unit requires 60 lbs pressure to process most wire. Hardened steel knives are adjusted to cut, strip, or slit or perform all three operations. All stripped material is removed automatically. The machine weighs approximately 75 lb.—*Williams Products Co., Middletown, Conn.*



CONDENSER MICROPHONE

For use as a non-directional, high fidelity studio microphone the Western Electric 640AA condenser microphone has a rising frequency response from 1,000 to 8,000 cps of 8 db and then drops uniformly to a level at 15,000 cps equal to that at 1,000 cycles. Output level is approx. 49.5 db below 1 volt per dyne/cm^2 with 200 volts polarizing potential. Output impedance is due to capacitance of 50 to 60 mmfd. The unit operates into the grid circuit of closely associated amplifier, such as the Western Electric RA-1095 amplifier.—*Western Electric Co., 195 Broadway, New York 7.*



UNBREAKABLE PANEL METERS

A new type panel meter built in all popular ranges of volts, millivolts, milliamps., and amperes uses a crystal clear plastic case with a full view unbreakable front cover which casts no shadows on the dial. Light shining on the edges of the case is dispersed by the plastic to illuminate the dial. The meters measure 3¾ in. wide by 3⅜ in. high and are moving coil type for dc or have repulsion iron vane elements for ac.—*Assembly Products Inc., Main and Bell Sts., Chagrin Falls, Ohio.*

MULTIPLE CRYSTAL HOLDER

Selection of any one of ten crystal controlled frequencies can be made by means of this rotatable crystal holder, which is no larger than a control knob and plugs into a standard five-prong tube socket. The holder is designed to accommodate from 1 to 10 metallized crystals, which are furnished in the frequency range from 3,500 to 9,500 kc within plus or minus 1 kc. The holder is completely sealed against moisture and dust.—*Scientific Radio Products Co., Council Bluffs, Iowa.*

SINGLE POLE TUMBLER SWITCH

Having a somewhat higher rating than the usual commercial types, this compact, single-pole, single-throw, flush tumbler switch is supplied with $^{13}/_{16}$ x $^{5}/_{8}$ in. molded bakelite base with silver-to-silver break contacts. Ball type handle or bat type handle can be furnished. The switch is rated 10 amps. at 125 volts.—*Ark-Les Switch Corp., 51 Water St., Watertown 72, Mass.*

IF WATER IS ONE OF YOUR RAW MATERIALS . . . AFFECTS YOUR PRODUCT OR PROCESS IN ANY WAY . . .

New FILT-R-STIL* Water Demineralizing Unit DELIVERS

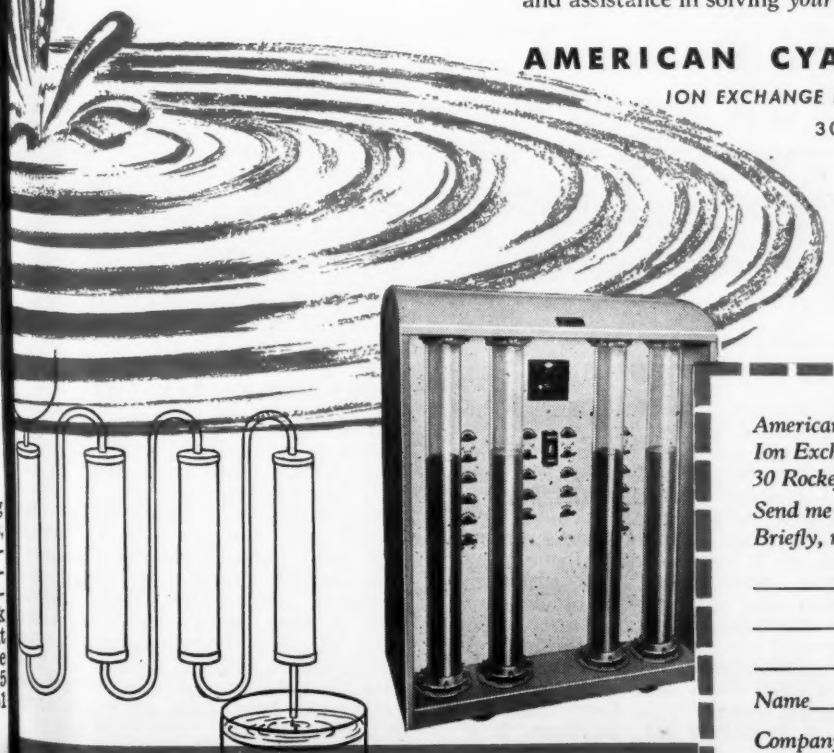
MINERAL-FREE WATER TO HELP YOU . . .

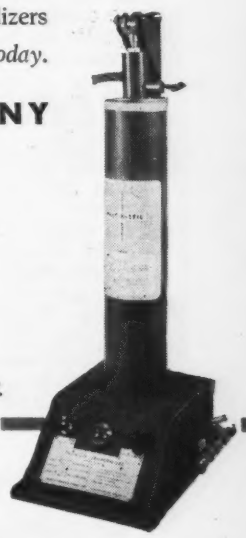
- **Improve Product Quality**
- **Lower Processing Costs**
- **Simplify Operations**

Now, thanks to Cyanamid's FILT-R-STIL Demineralizing units, you can have quality-controlled water day-in and day-out . . . water which is chemically equal or superior to distilled. FILT-R-STIL Demineralizers are economic, too. The IONAC* Resins used make the process comparable to a simple cold filtration. The added expense of heat, cooling water and periodic dismantling have all been eliminated.

All standard units (capacity from 5 to 1200 or more gallons per hour) are compact and completely self-contained. And the ease with which they're installed, operated and maintained further assures long, efficient service and reliable results. For complete data on FILT-R-STIL Demineralizers and assistance in solving *your* water problems—mail coupon *today*.

AMERICAN CYANAMID COMPANY
ION EXCHANGE PRODUCTS DEPARTMENT
30 ROCKEFELLER PLAZA
NEW YORK 20, N. Y.





**Reg. U. S. Pat. Off.*

FILT-R-STIL Demineralizer works . . . Units consist of four "beds" of IONAC* Resins by principle of ion exchange, successively remove the dissolved minerals from water. is fed through a conductivity cell which indicates quality of water being produced. esins are exhausted, a regenerative system restores units to full efficiency.

American Cyanamid Company,
Ion Exchange Products Dept. 10
30 Rockefeller Plaza, New York 20, N. Y.
Send me your free booklet on FILT-R-STIL. T.T.1
Briefly, my water problem is of the following nature:

_____

_____

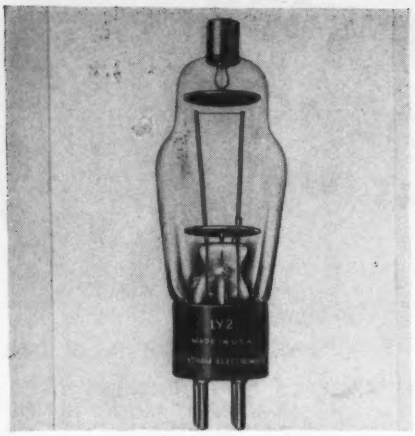
_____

*Name*_____

*Company*_____

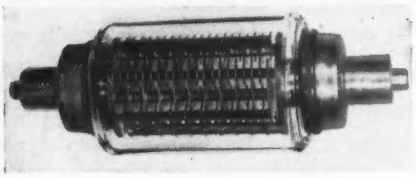
*Address*_____

*City*_____ *State*_____



TELEVISION RECTIFIER TUBE

Designed for the anode supply in direct view or projection type television tubes, the Chatham 1Y2 high voltage rectifier has a peak inverse voltage rating of 50 kv. Filament voltage may fluctuate between 1 and 1.65 volts for 60 cycle operation or rf filament supply. Two tubes deliver 50 kv dc in a voltage doubler circuit or 25 kv dc singly.—*Chatham Electronics, 475 Washington St., Newark 2, N. J.*

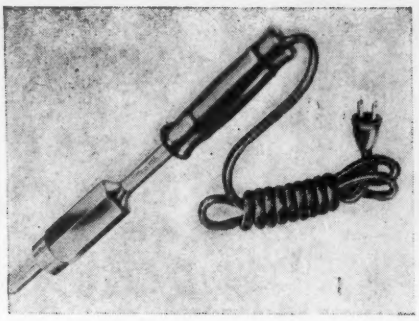


VACUUM TUBE CAPACITORS

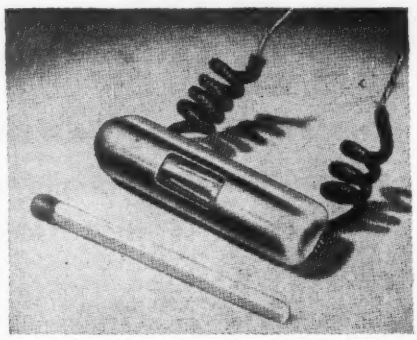
Overcoming the inability of vacuum capacitors to handle high voltage and high current requirements simultaneously and their serious mechanical resonance the RC100-20 line of vacuum capacitors permits high rf currents without overheating. This is accomplished by silver-plated copper contact terminals, large diameter copper-to-glass seals, and a multi-plate assembly brazed into a single unit. The units have a capacitance value of 100 mmfd ±4%, a peak rf voltage of 20,000 and max. dc voltage of 16,000 at an rms current of 60 amps. They may be used at frequencies up to 30 mc and at an ambient temperature up to 50° C. —*Raytheon Mfg. Co., Power Tube Div., Waltham 54, Mass.*

SOLDERING IRON

An addition to a line of industrial electric soldering irons, the new Hexacon is wound for 300 watts and has a ⅜ in., instead of the conventional ⅞ in., diameter tip. Especially recommended for production line soldering, the new construction provides high heat for a small tip cross-section and permits faster soldering. The heating element is high grade nickel-chromium resistance wire insulated with mica. The case made from solid

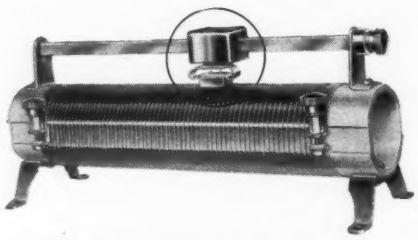


hexagon steel affords high mechanical strength. The iron may be ordered for any voltage, ac or dc.—*Hexacon Electric Co., 157 West Clay Ave., Roselle Park, N. J.*



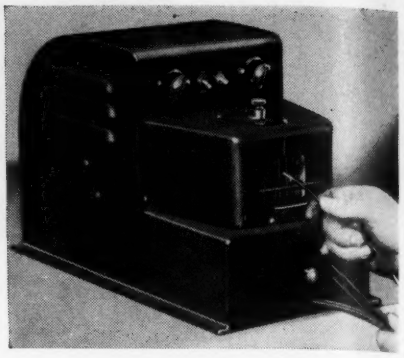
MINIATURE NEON LAMP

Suitable for instrument panels, switchboards and electrical appliances this miniature neon pilot lamp consumes under 1/10 watt and operates at any voltage from 75 to 250 ac or dc. The Tiny-Glow pilot light is shock- and vibration-proof and has a life of over 10,000 hours. The chrome plated metal casing requires only two 13/64 in. holes in the panel for mounting. Standard studs are 3/8 in. long but other lengths are available.—*Industrial Devices, Inc., 22 State Rd., Edgewater, N. J.*



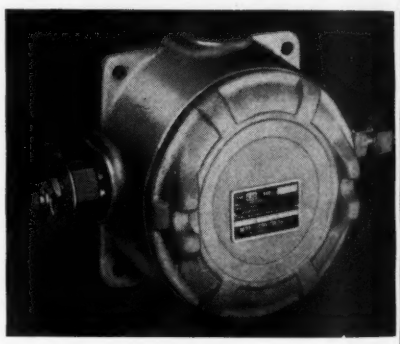
SLIDE-CONTACT RHEOSTAT

A floating contact element has been added to the new type E tubular slide-contact rheostat which provides equal, self-adjusting contact pressure against slider bar and winding and lubricates both slide paths. This floating element consists of 2 copper-graphite contact blocks, connected by a phosphor bronze leaf spring. The blocks have low intermediate resistance. The 450 watt rheostat is available in 16 different ohmic values and can be furnished with non-inductive and tapered winding.—*Rex Rheostat Co., 3 Foxhurst Rd., Baldwin, L. I.*



WIRE STRIPPER

Intended to speed production by faster, more efficient wire stripping of cotton, silk, synthetic and rubber covered insulation, this hot blade wire stripper cleanly burns off insulation up to ⅜ in. diameter. The blunt electrically-heated stripping blades cannot cut or otherwise harm the finest strands. Each blade has individual heat control for heavy, average and light insulation. The strippings fall into a water drawer. The unit operates on 115 volt, 50-60 cycle, ac.—*Ideal Industries, Inc., 4037 Park Ave., Sycamore, Ill.*



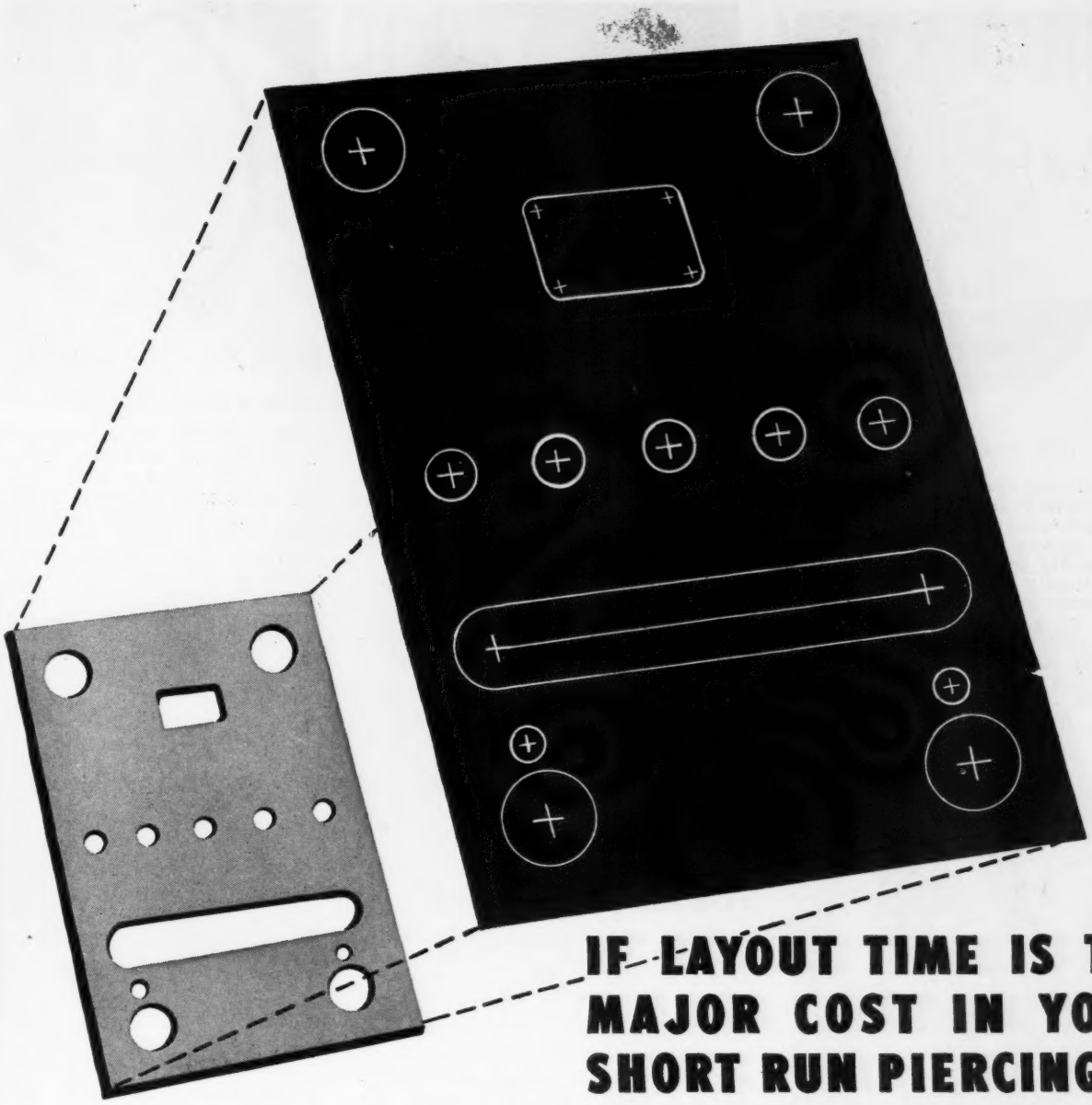
EXPLOSIONPROOF THERMOSTAT

Especially designed for applications where dust and fumes are prevalent type EJO remote bulb thermostat is a low-cost explosion-proof control which may be mounted in any position on a flat surface. Suitable for pilot duty the unit has an external adjustment with 120°F or 250°F range in models covering —120°F to 600°F. Four remote bulb styles are available. The unit is rated 1200 watts non-inductive or 300 watts inductive, 115-230 volts, ac.—*United Electric Controls Co., 69-71 A St., Boston, Mass.*

OHM'S LAW CALCULATOR

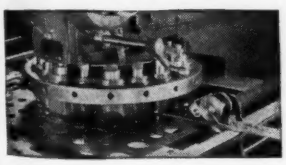
The answer to any Ohm's law problem is obtained with one setting of the slide by means of the new pocket-size calculator, which reads directly in ohms, volts, amperes, and watts. The calculator will also solve parallel resistance and series capacitance problems, multiply and divide, find squares and square roots. The opposite side of the device contains the composition resistor color code and catalog numbers of stock resistors. —*Ohmite Mfg. Co., 4937 Flournoy St., Chicago, Ill.*

are exhausted, a regenerative system restores units to full efficiency.



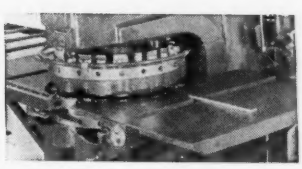
IF LAYOUT TIME IS THE MAJOR COST IN YOUR SHORT RUN PIERCING...

... talk to the man who has a WIEDEMANN



PIN TYPE GAUGE

The Pin Type gauge consists of a back gauge bar operating in and out parallel to the punch and die in the working position and controlled by a handwheel conveniently located for the operator. A series of holes are drilled in the gauge bar on ⅛" centers . . . four rows across and each spaced ⅛" beyond the preceding hole. By dropping pins of various diameters into these holes, any dimension down to increments of 1/32" can be obtained. The standard length for the Pin Type Gauge is 30" but the gauge can be supplied in lengths of 48"



RACK TYPE GAUGE

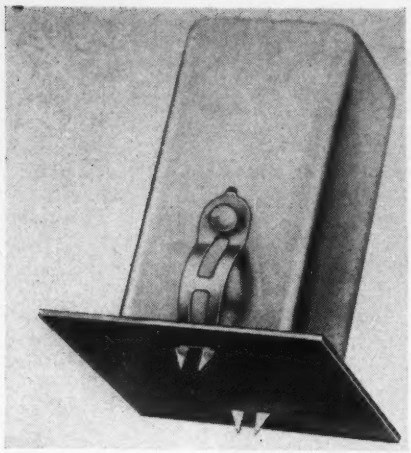
An accurate rapid gauging arrangement for longer runs from 25 to 1000 pieces of a kind. The handwheel and dial control the in and out movement of the rear gauge bar, which moves parallel to the punch and die by means of two lead screws on either side of the press. Cross dimension is obtained by two ⅛" circular pitch racks mounted face to face and extending to the right or left of the machine, whichever is more desirable to the user. Stops are provided to drop into the racks. By rotating the entire stop 180 degrees, dimensional increments of 1/16" and ⅛" are obtained. Other stops provide for 1/32" increments.

A Wiedemann Turret Punch Press completely eliminates or greatly reduces layout time. For example: on a Wiedemann equipped with a gauge table, all layout readings are taken from the blueprint or chart and then immediately positioned on the gauge table where the work is pierced.

Get the facts . . . the complete story of short run piercing economy. See for yourself how a Wiedemann Turret Punch Press can save you up to 2000% in labor alone. Then if you want to see a Wiedemann in operation, write us and we'll tell you of a shop near you that's using a Wiedemann for short run piercing.

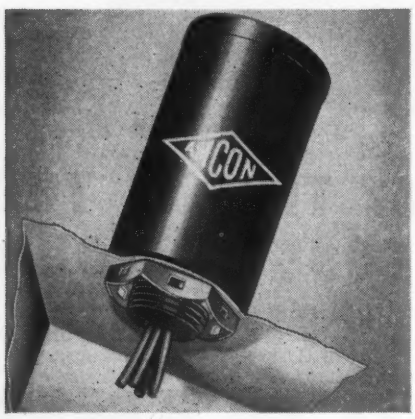
WIEDEMANN MACHINE COMPANY

1309 SEDGLEY AVENUE • PHILADELPHIA 32, PA.



SHIELD CAN FASTENERS

Eliminating spade lugs, nuts, and lockwashers Palnut shield can fasteners provide fast, efficient shield can-to-chassis assembly by snapping quickly into chassis holes and automatically locking. The fasteners accommodate a wide range of chassis thicknesses, since the long spring arch construction provides flexibility for variations in hole locations in cans and in chassis thickness.—*The Palnut Co.*, 83 *Cordier St., Irvington* 11, *N. J.*

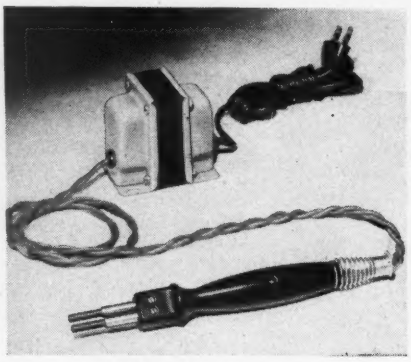


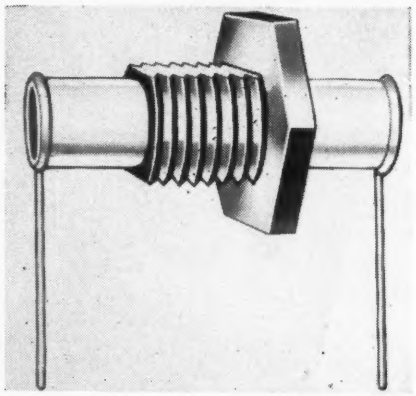
ELECTROLYTIC CAPACITOR

Intended for top chassis mounting this electrolytic capacitor, encased in a plastic case, measures 2⅛ in. height and 1⅜ in. diameter. Self-insulating because of its molded plastic case the unit will withstand high temperatures and has a wide climatic range. It is available in a variety of standard capacities and in multiple values up to 450 volts working voltage.—*American Condenser Co.*, 4410 *N. Ravenswood Ave., Chicago* 40, *Ill.*

SOLDERING TOOL

Designed for fine precision work and for soldering in hard-to-reach locations the ST-1 soldering tool requires no preheating and draws operating current only when in contact with metal. The carbon holder keeps carbon breakage to a minimum and fork type design eliminates necessity of grounding work. The tool uses 3/16 in. carbon tips. A transformer reduces voltage across carbon rods to 6 volts. The unit operates on 110-120 volts, 50-60 cycles, ac and consumes 96 watts.—*Thermador Electrical Mfg. Co.*, 5119 *District Blvd., Los Angeles* 22, *Cal.*



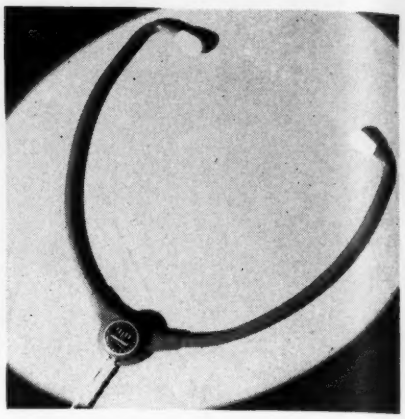


FEED-THROUGH CAPACITORS

Fitted with brass, cadmium plated feed-through bushings, this series of high-Q feed-thru capacitors is designed to attain efficient by-passing capacity to ground when feeding through a chassis or metal cover. The capacitors are the tubular ceramic type, and range from 5 mmfd to 17,500 mmfd in capacity. Size range of bushings is from .243 in. od, 28 thread, to ⅜ in. od, 24 thread, class No. 2 fit. Length exclusive of head is 3/32 in. to 5/16 in. accommodating capacitors to .272 in. od.—*Electrical Reactance Corp., Franklinville, New York.*

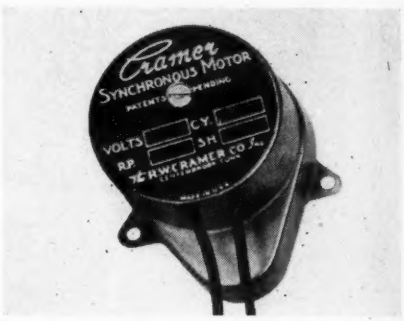
TRANSMISSION LEAD-IN LINES

Rugged and flexible, Anaconda type ATV two-wire polyethylene insulated line is for use between antenna and television or FM receiver, and is designed for direct installation from overhead antennas along roof structures and building sides. Type ATV-300S is the standard line weighing 14.1 lbs/1000 ft., while type ATV-300L is a lightweight TV lead-in line with a weight of 11.5 lbs/1000 ft. Characteristic impedance for both is 300 ohms. Attenuation at 50 mc is 0.68 db/100 ft., at 100 mc it is 0.85 db/100 ft.—*Anaconda Wire & Cable Co.*, 25 *Broadway, New York.*



LIGHTWEIGHT HEADSET

Molded of lightweight, tough Tenite plastic and worn under the chin rather than over the head, the Telex Monoset reduces ear pressure and head fatigue to a minimum. The tiny speakers are mounted on two hollow Tenite tubes which are adjustable for proper width. Good frequency response, ruggedness, and durability are characteristics of the headset. The entire unit weighs 1.2 oz. —*Telex, Inc., Minneapolis, Minn.*



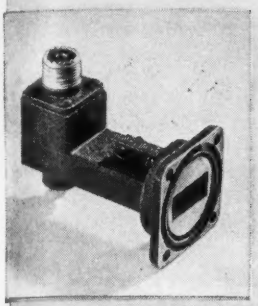
SYNCHRONOUS TIMING MOTOR

Intended primarily for industrial applications which require a constant speed at a given frequency, such as timing devices, recording instruments, heating controls, etc., the SX Synchronous Motor has a high torque of 30 in-oz at 1 rpm with a power input of only 2.7 watts at 115 or 230 volts, 60 cycles, ac. Twenty-eight standard gear trains ranging from 60 rpm to one revolution in 24 hours can be provided with the unit which has a rotor speed of 240 rpm at 60 cycles. Gear trains and coils of the motors are interchangeable.—*R. W. Cramer Co., Centerbrook, Conn.*

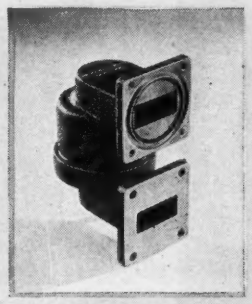
VOLUME CONTROL REPLACEMENT KIT

An assortment of volume and tone controls with attachable switches, servicing about 95% of standard replacement needs, compose the new Serviceman's Kit No. 4. The steel cabinet contains 17 controls, 8 switches and four glass-insulated flexible resistors. The controls and switches are individually packed in standard cartons. *Clarostat Mfg. Co.*, 130 *Clinton St., Brooklyn* 2, *N. Y.*

EVERY DE MORNAY-BUDD WAVE GUIDE
is Electrically Tested, Calibrated and Tagged

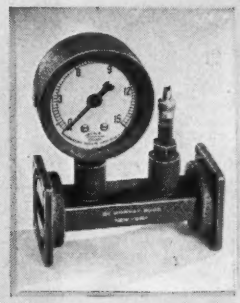


Crystal Mount DB-453

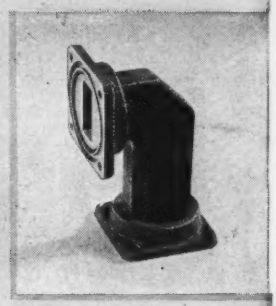


Rotating Joint DB-446

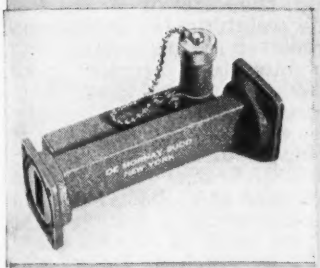
90° Elbow (H Plane) DB-433



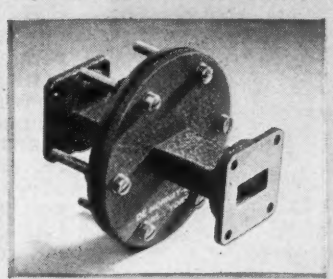
Pressurizing Unit DB-452



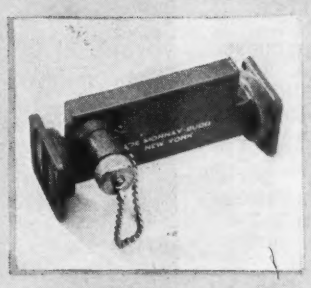
Mitered Elbow (H Plane) DB-439



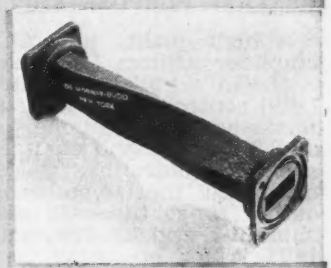
Uni-directional Broad Band Coupler DB-442



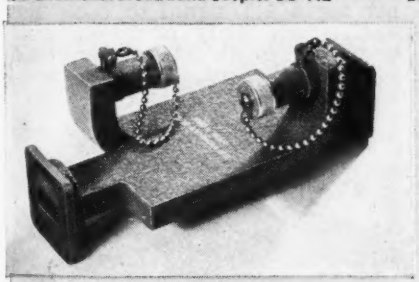
Bulkhead Flange DB-451



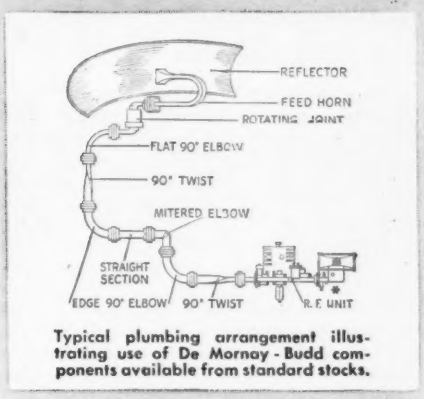
Uni-directional Narrow Band Coupler DB-440



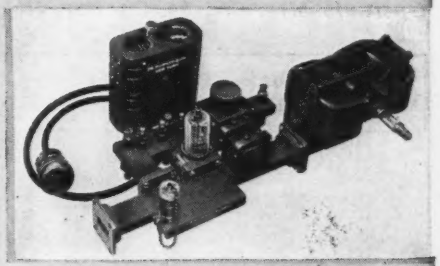
90° Twist DB-435



Bi-directional Narrow Band Coupler DB-441



Typical plumbing arrangement illustrating use of De Mornay-Budd components available from standard stocks.



RF Radar Assembly DB-412

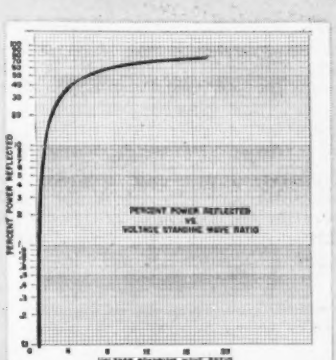
When you use any De Mornay·Budd wave guide assembly, you know exactly how each component will function electrically. You avoid possible losses in operating efficiency through impedance mismatches, or breakdown and arcing caused by a high standing wave ratio. (See chart below.)

De Mornay·Budd wave guides are manufactured from special precision tubing, and to the most stringent mechanical specifications. Rigid inspection and quality control insure optimum performance.

NOTE: Write for complete catalog of De Mornay·Budd Standard Components and Standard Bench Test Equipment. Be sure to have a copy in your reference files. Write for it today.

The curve shows the manner in which the reflected power increases with an increase in the voltage standing wave ratio. The curve is calculated from the following equation:

$$\% \text{ Power Reflected} = \left(\frac{\left(\frac{V_{max}}{V_{min}}\right) - 1}{\left(\frac{V_{max}}{V_{min}}\right) + 1} \right)^2$$



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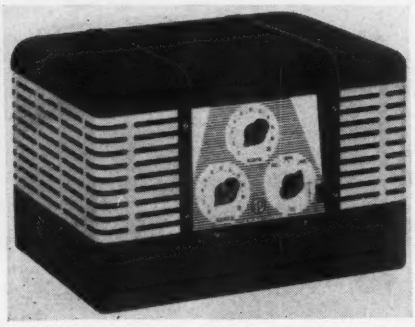
EQUIPMENT FOR 97% OF ALL RADAR SETS

De Mornay-Budd, Inc., 473 Grand Concourse, New York 51, N. Y.

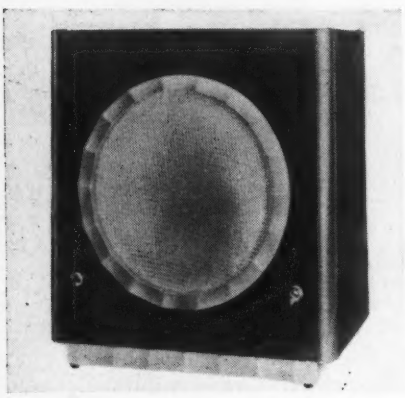
Communications Components



GENERAL PURPOSE AMPLIFIER

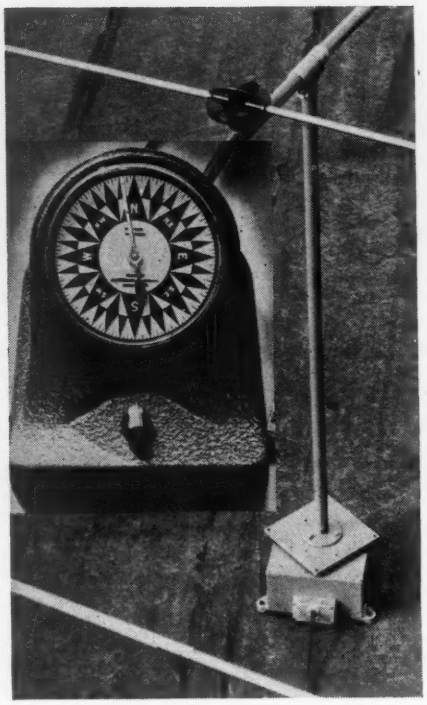
A high quality general purpose amplifier utilizes four tubes, with a 6L6GA supplying 8 watt output. Level controls are provided for the four-stage microphone channel, and 3-stage phono channel. A 3-step tone control has "voice," "normal," and "music" positions. Three output range taps will match 3-5 ohms, 6-8, and 400-600 ohms. Model 1A35 is for operation on 105-125 volts, 50-60 cycle, ac, and has a power consumption of 65 watts.—*Operadio Mfg. Co., St. Charles, Ill.*

NEW LAB EQUIPMENT
SEE PAGE 90



SOUND REPRODUCER

Model CE-26 sound reproducer provides 8 watts undistorted output for record reproduction and PA applications with a frequency response flat within two db from 60 to 8,000 cps. Using two 6V6GT's in the output stage, intermodulation is less than 8% at normal output. Input impedance on the phono-channel is 500,000 ohms with 0.5 volts required for full output. Impedance on the microphone channel is 10 megohms. Tone control is provided. The unit is supplied with case and 10 in. matched pm speaker. It operates on 115 V., 60 cycle, ac and consumes 70 watts. —*The Allen D. Cardwell Mfg. Corp., 97 Whiting St., Plainville, Conn.*



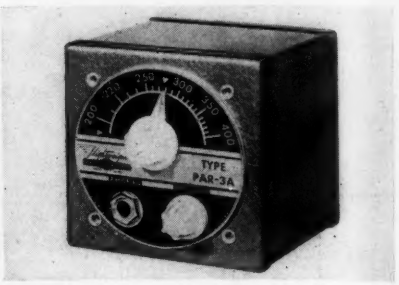
ANTENNA ROTATOR

Eliminating the use of costly and troublesome rotating joints and coupling devices the Workshop antenna rotator is built to rotate uhf antennas and permits use of low loss coaxial line without break from transmitter to antenna. A single 3-way switch provides rotation in either direction with instant reversal up to 360° at 1 rpm per minute. The unit automatically stops to avoid breaking or twisting coaxial lines. Self-lubricating oilite bronze ball bearings are used in the rotator for large weight support and quiet operation. An indicator is housed in a separate aluminum casting. The motor operates on 110 volts, 60 cycle, ac.—*The Workshop Associates, 66 Needham St., Newton Highlands 61, Mass.*

FM STAND-BY ANTENNA

Weighing less than 15 lbs. and easy to install on any existing support, the "1200" antenna is a small, light, folded dipole turnstile designed to serve as FM stand-by emergency antenna till standard antennas become available. The antennas are factory-tuned to the center of a specified channel and are supplied with individually measured radiation pattern. The unit can be fed by a permanent line, or by RG20/U solid dielectric cable.—*Andrew Co., 363 East 75th Street, Chicago 19, Ill.*

NEW DESIGN PARTS
SEE PAGE 96



AIRCRAFT RANGE RECEIVER

Having the size of 3 11/16 in. cube and weighing 1½ lb this small range receiver for personal aircraft can be mounted directly in the instrument panel or may be attached to the battery box. A fibre board box is supplied with the receiver for mounting the standard 67½ volt (8.5 ma) "B" and 1½ volt (.25 ma) "A" batteries. The PAR-3 receiver is a 4 tube superheterodyne with a tuning range from 195 to 410 kc. Using an if of 455 kc it has a sensitivity of 8 mv for a 4:1 signal to noise ratio and a selectivity of 25 kc bandwidth for 40 db attenuation. Maximum audio output is 125 mw.—*Bendix Radio Baltimore 4, Md.*

OMNIRANGE CONVERTER

Intended to be used in conjunction with Lear vhf receiver the omnirange converter model OML-1 provides reception and indication of vhf omniranges and runway localizers. The converter contains filters, discriminator circuits and power output stages for use with vhf omniranges. Primary power supply is the 24-volt aircraft battery. Power consumption is 900 ma at 24 volts and 50 ma at 270 volts. Omnirange indicator and localizer indicator are located on the instrument board. The system detects aircraft position changes of 1° with a signal input of 10 microvolts. At 15 microvolts input bearings accurate to within 2° can be obtained. —*Lear Inc., Grand Rapids, Mich.*

(*Continued on page* 137)

TELEVISION INTERFERENCE

(*Continued from page 78*)

they leave the transmitter, and the interference which is transmitted vertically polarized.

Of course, it is well known that the plane of polarization often rotates, due to reflections, reradiation, etc., before it arrives at the receiver. However, if the horizontal dipole antenna at the TV receiver could be on a ball-and-socket mounting and moved to obtain an optimum position for reducing vertically polarized interference from mobile transmitters on the nearest highway, it might be found that a usable TV signal could be received.

Second, experiment might show that there is an optimum position in a 6 mc wide TV channel for the location of a narrow band of interfering signals, say at about 4.25 mc from the TV carrier. If the frequencies of all transmitters sharing the TV channels were located within this narrow band in each channel, then TV sets could be equipped with sharp filters to be switched into use while the interference was on the air. Such filters might not noticeably reduce the fidelity of the picture being received.

From an overall consideration of TV channel sharing it will be seen that no one can predict with certainty what we will face when all the channels are in use and *shared*. It may help those in the television industry to keep in mind the fact that commercial TV channels are not exclusively TV. It is reassuring to know that the FCC is studying the matter from the engineering viewpoint, and the Commissioners are cognizant of the possible effects resulting from the dual use to which these channels may be put in the not too distant future.

New Inductive Home

Inductive Equipment Corp. has moved into a new building at Gettysburg, Pa., after operating for nearly a year in temporary quarters. The company produces magnet wire, transformers, rectifiers and various types of high frequency equipment.

THE GENERAL ELECTRIC VARIABLE RELUCTANCE PICKUP

RECORD enthusiasts are critical customers—whether they be devotees of Bach or boogie-woogie. Better and better reproduction of their favorite recordings is an insistent demand that must be met.

The General Electric Variable Reluctance Pickup can help you to meet that demand. It will appeal immediately to the technical mind due to its simplicity and direct resolution of difficulties often associated with phonograph pickups.

Check this list of major features:

- Low Needle Talk
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Consult Wells for Quality Radio Parts

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WIDE READING

(*Continued from page* 83)

angles. The radar signals obtained during the short periods of time when the rotating beam covers the area to be recorded is stored on the screen of a storage cathode-ray tube; then it is taken off the screen by a conventional facsimile recorder and recorded during the much longer periods available between scanning of these areas.

The storage screen comprises a sheet of insulating material covered with separate, parallel strips of conducting material; a metal coating on the other side of the insulating material serves as signal plate and is connected to the output resistor. It will be clear from this description that the storage screen is made up of narrow, parallel individual strips. Deflection of the electron beam in only one direction is therefore necessary.

A PPI tube continuously shows the area flown over by the plane carrying the recording equipment. In the signal take-off position shown in the drawing, the relay-operated switches will cause a low velocity electron-beam to scan the screen of the storage cathode-ray tube generating a signal across the output resistor which is amplified and recorded. Triangular deflecting currents are supplied by potentiometer 67. Upon operation of the controlling relay, the switches will, for a short time interval, assume signal storage positions where signal voltages are fed to the control grid of the storage tube and electrode potentials produce a high-velocity electron beam which scans the screen rapidly as compared with the slowly moving take-off scanning of the low-velocity beam. Deflecting currents are provided by sawtooth generator 23. The relay controlling the switches is synchronized with the antenna rotation; the same motor drives the scanning drum of the recorder and operates the deflection systems for the two CR tubes.

In an alternative arrangement two electron guns are arranged in one tube to alternately produce the slow and the fast electron beams; they scan different parts of the parallel strips on the screen, moving at right angles to the individual strips.

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For finest performance—in new installations as well as for replacements. Crescent Speakers and Record Changers deliver complete satisfaction—to the user in their true toned fidelity reproducing of AM-FM and Records—to the manufacturer and repair man in easy installations and customer acceptance.

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Crescent Record Changers: Play 12-10" or 10-12" records.

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4132-52 W. BELMONT AVENUE, CHICAGO 41 ILLINOIS

NEWS OF INDUSTRY

(*Continued from page* 88)

American or other important field office, $100,000 for frequency shift receivers and tape recorders at the various field offices, $60,000 for telephone privacy devices for the single sideband voice channels proposed between UN Headquarters and the two main field offices, and $10,000 for studio-transmitter and studio-receiving station links, a total of $5,912,000.

A note on the equipment statistics added that the "cost figures in this report are estimates based on past experience in the procurement of similar equipment and materials. Wherever possible, tentative quotations were obtained from suppliers. It is proposed that all contracts for procurement and for performance of the construction and installation be awarded after taking

sealed bids from a number of recognized suppliers or contractors, of all member nations, in each of the various fields involved."

Surveys by the group show that an estimated one sixth of the world's population, about 303,975,000 persons, constitute the listening audience for the UN and associated broadcasts. The inquiry covered listening habits in 51 nations, for both long- and short-wave broadcasting.

FM Broadcasters Form Association

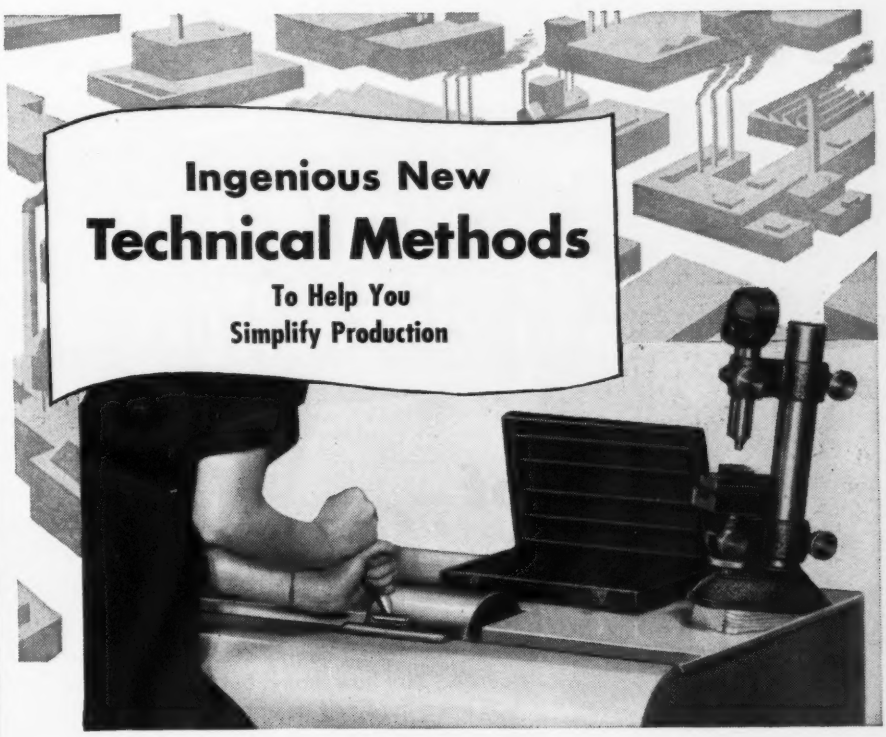
Predictions that the FM set manufacturing business would amount to $100 million a year and by the end of 1947 five million home receivers would be produced were made at the organization meeting of the FM Association in Washington in mid-January which was attended by over 300 broadcasters and manufacturing company officials. Seven hundred FM broadcasting stations will be in operation by the end of this year, it was also forecast.

The FM Association unanimously elected Roy Hofheinz, KTHT-KOPY, Houston, Texas, as president; Everett L. Dillard of KOZY, Kansas City, and WASH, Washington, vice-president; Frank Gunther, vice-president of Radio Engineering Laboratories, as secretary; and Arthur Freed, vice-president and general manager of Freed Radio Corp., as treasurer. J. N. (Bill) Bailey, associate editor of *Broadcasting Magazine,* was selected as the FMA executive director and assistant secretary-treasurer.

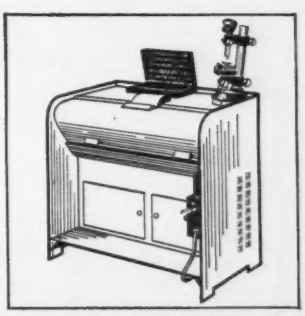
The board members of FMA, unanimously elected, were: three year terms—C. M. Jansky, Jr., (Jansky & Bailey); W. R. David, (General Electric Co.); Messrs. Hofheinz and Dillard. Two year terms—Stanley Ray, (WRCM, New Orleans); Leonard Asch, (WBZA, Schenectady); R. F. Kohn, (WFMZ, Allentown, Pa.); Frank Gunther. One-year terms — Gordon Gray, (WMIT - WSJS, Winston - Salem); Ira Hirschman, (WABF, New York); Wayne Coy, (WINX-WINX-FM, Washington); E. J. Hodel, (WCFC, Beckley, W. Va.). The executive committee is composed of Hofheinz, Dillard, Coy, Asch, and David.

Professor E. H. Armstrong, inventor of frequency modulation, expressed the view that, based on December's consumer purchases of FM sets, the FM set business has a potential of $100 million a year and "is going up". He declared "The evidence indicates manufacturers can sell FM sets as fast as they can be turned out." W. R. David, General Electric FM transmitter sales manager, forecast that the manufacturing industry could provide transmitters for the 700 stations which had been previously predicted by FCC Chairman Charles R. Denny, Jr., as the outlook for the stations in operation by the end of 1947. David also asserted that by the end of this year around 5 million FM receivers will have been produced.

The present year, 1947, was generally hailed by these speakers, together with executives of a half dozen other leading manufacturing companies, as "FM's Year." The other leading speakers were Dr. Ray H. Manson, President of



New Centerless Lapping Machine Gives Precision of Less Than 2 Micro-Inches!



Centerless Lapping Machine

Now it's easy to lap cylindrical pieces—quickly—accurately—without specialized operator skill! The new Size Control Centerless Lapping Machine handles pieces from .010″ to 10″ diameter without costly set-ups.

The operator merely holds piece between lapping rolls with stick. Pressure applied determines quantity of metal removed. Small roll turns piece at slow constant rate. Large roll turns more rapidly to remove minute quantities of metal. Ideal for lapping oversize gages, worn gage plugs to next smaller size, bearings, bushings or shafts. Roll speeds easily changed. Adjustable for tapers.

Ideal also to save time on the job, is chewing gum. The act of chewing aids the workers' concentration; seems to make work go easier. Furthermore, chewing gum may be used even when both hands are busy—increasing worker safety—and reducing work interruptions. That is why many plant owners have made Wrigley's Spearmint Gum available to all.

You can get complete information from
Size Control Company
2500 Washington Blvd., Chicago 12, Ill.

AB-54

the Stromberg-Carlson Co. who forecast that twenty to thirty per cent of the 1947 set output would be equipped for FM and that by December, 1947, the production would be about 400,000 FM sets monthly, compared with 40,000 in December last year; A. R. Hopkins of RCA Victor Division; Norman Wunderlich of Federal Telephone & Radio Corp.; Fred Fisher of Westinghouse; Lester Whitten of Western Electric and Graybar; and Edward G. Taylor, Zenith Radio advertising and sales promotion manager, Chairman of the Radio Manufacturers Association committee in charge of the "Radio in Every Room" campaign.

TBA Re-Elects Poppele

Jack Poppele was re-elected president of Television Broadcasters Association at that organization's January annual meeting. G. Emerson Markham (GE) is the new vice-president, other officers elected being: Paul Raiburn, assistant secretary-treasurer; Will Baltin re-elected secretary-treasurer, John Royal (NBC) and Frank P. Schreiber (WGN) directors.

Cambridge Technical Meet

North Atlantic Region, Institute of Radio Engineers has scheduled an all-day meeting for May 3 at the Continental Hotel, Cambridge, Mass. There will be six technical sessions, none held concurrently, as well as an exhibition of electronic equipment and parts. John M. Clayton, General Radio Co., 275 Massachusetts Avenue, Cambridge, Mass., is handling many of the details.

NAB Adds 129

The National Association of Broadcasters, which concluded its 1947 meeting at the Hotel Mark Hopkins in San Francisco early in January, is 129 members larger than it was before the gathering. That many new members were admitted to the association. Total membership now touches 1282 active and associate members as compared with a total of 536 at the time the last meeting was held in San Francisco in 1940. The 1947 Annual Convention is to be held in Atlantic City with the date tentatively agreed upon as September 15 for the yearly membership meeting.

Harvey's LF Loran

The recent PICAO radio navigation technical committee at Montreal gave its full recommendation to the use of the United States' low frequency Loran system. The LF system development work was started at the Radiation Laboratory of the Massachusetts Institute of Technology during the war and, upon disbanding of that Laboratory, development work was continued by the Harvey Radio Laboratories, Inc., Cambridge, Mass., for the Army Air Forces' Watson Laboratories, a key electronics research center of the AAF.

The Washington News page in the January, 1947, issue of TELE-TECH incorrectly stated that the Low Frequency Loran development work had been carried on exclusively by the Hazeltine Corp.

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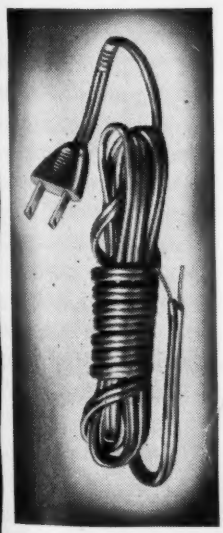

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The Plug is Designed with thoughtful consideration to the stress and strain of ordinary and extraordinary use. An adequate finger grip for safe removal and a projecting surface to insure against finger slippage on insertion in the outlet is provided.

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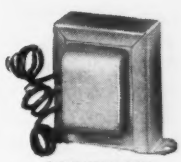
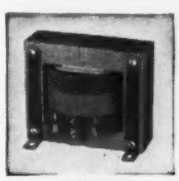
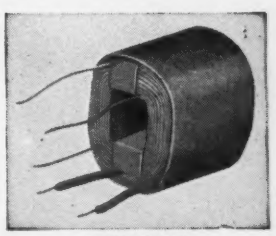


LOW VOLTAGE TRANSFORMER

RELAY COIL



POWER TRANSFORMER



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PICAO RECOMMENDS

(*Continued from page 43*)

information supplied from the plane; (11) for specially equipped aircraft, ground selection of height layers for study.

Aerodrome surveillance requirements are provided for in detail and there is a requirement for location of dangerous clouds. Also, requirements are set up for visual presentation of communications and automatic display of aircraft movements and for information storage.

A requirement is set up for automatic traffic analyzers and computers for use in congested landing areas.

In regard to long distance aids to navigation, coverage is required 1500 miles over water and 750 over land and error limits are set up.

In regard to collision warning, interesting requirements are that the system shall not depend on alertness of crew, should distinguish between types of hazards and should not require beacon installations on hazards!

Committee A also specified accuracy requirements for automatic all-weather approaches and landings. These are reproduced herewith in Figs. 2 to 7.

In closing their session, the Radio Technical Division delegates all agreed to use their best efforts to get their respective governments to adopt the standard systems and to retain now standard ones (such as Babs, Consol, High Power medium frequency beacons) only so long as standard systems cannot be installed.

In an address to the delegates, Dr. E. P. Warner, president of the Interim Council heading PICAO emphasized that experience has shown it is unwise to await the perfect scheme in the application of new devices. Better use the imperfect one said he, gaining experience and making modifications as these become possible and desirable.

It is in this spirit that PICAO plans to progress.

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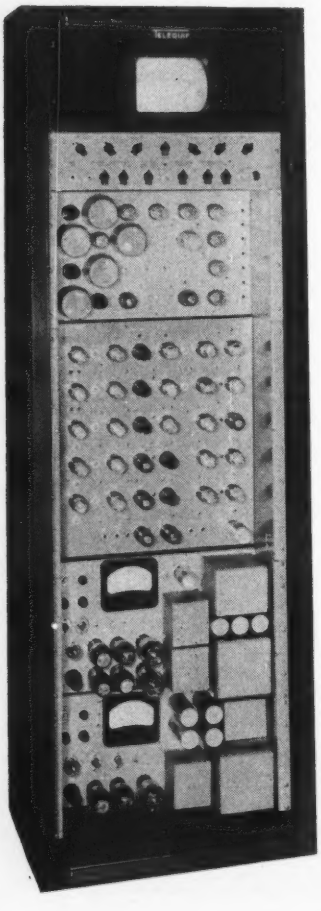
Synchronizing Generator and Monitor



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TELE-COMMUNICATIONS

(*Continued from page 65*)

which is set for an all-time high of about 1,750,000, is almost certain to be exceeded since present output rate has been steadily rising ever since beginning of 1946. Present production figures are better than best prewar year of 1938 with a total of 1,600,000 sets.

AMERICAN TUBE IMPORTS TO ENGLAND—Licenses to import U.S. radio receiving tubes have been procured by 34 importers from the British Board of Trade. The Federation of Anglo-American Importers, which secured the licenses, estimated that the total quantity of American tubes imported will amount to approximately 100,000 valued at $35,000. The Federation of Importers also is negotiating for importation of American home radio sets into the United Kingdom, seeking to have the latter placed on the British Token Import Plan List.

Hexacon Enlarges

A new addition to its plant considerably increasing facilities, has been occupied by the Hexacon Electric Co., Roselle Park, N. J. General offices will remain at 157 West Clay Avenue.

PRECISION OSCILLATORS

(*Continued from page 73*)

perature over the operating range. A very high degree of uniformity is obtained from production capacitors; in fact, the production units now available are better than the laboratory standards available a few years ago. A typical temperature-capacity curve for a 1000 mmfd capacitor is shown. The coefficients shown on the curve are in terms of frequency since increments of frequency are easier to measure than increments of capacity. Multiply these values by 2 for corresponding capacity coefficients.

It will be observed that the temperature coefficient of this capacitor varies in slope as the temperature is changed. For ordinary purposes this change would be considered inconsequential. For precise frequency control it is important that these curves be very similar where comparison is made between production units. These curves repeat very well whether the data is obtained from increasing temperature condition, or a decreasing temperature condition. This assumes that moisture effects are reduced to a low value.

Linearity Compensation

A linear curve would be more desirable for these capacitors, but since they are not linear then some other element in the circuit must be made to compensate for this non-linearity. The inductance considerations in a master oscillator must include the coil form, coil winding, the core and the lead screw. This may sound rather inclusive, but if extreme stability is required no stone can be left unturned.

The smallest diameter powdered iron core which may be produced with a high degree of uniformity is the one-half inch size. The choice of this size core then determines the size of the coil and coil form to be used to cover the desired ratio.

A tuning ratio of 1½ to 1 was chosen because a higher degree of calibration accuracy was possible. A linear dial rotation versus frequency characteristic was desirable

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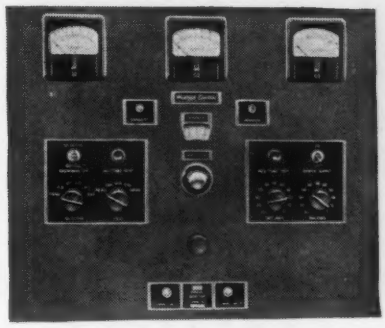

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because of calibration simplification and is obtained through the use of a variable pitch winding on the oscillator coil. Tuning curves which depart from this linear relationship less than 500 cycles in the 1 megacycle region are possible. By using cam correcting devices, it is possible to hold the departure from a linear calibration to 100 cycles or less.

Core Materials

Many different core materials are available but only a few are suitable for use in stable oscillators. A typical temperature-frequency curve for a coil used in a 2 to 3 megacycle oscillator is illustrated. Again the change is in parts per million in frequency (because frequency is more convenient to measure than increments of inductance). A curvature in either direction in the frequency temperature-characteristic of a coil may be obtained by the selection of the proper radial and axial coefficient of the coil form. This property is used to compensate for the curvature in the temperature-capacity curve for the tuning capacitor.

The development work required in order to obtain a good master oscillator consists of a combination of theory and good laboratory technic.

Since the coefficient of expansion of the various components enters into the final result so markedly, it is necessary that a good method for measuring the temperature coefficient of expansion of various materials be available. A rather novel method for making these measurements was developed whereby an oscillator was used to measure the coefficient of expansion in terms of frequency. For example:

If an oscillator be made to cover a one megacycle range linearly with one inch of motion, then each one millionth of an inch represents one cycle change in the oscillator frequency. By using a properly designed instrument such a device can be made to produce excellent temperature-expansion curves with a very high degree of reliability. One can not help but be amazed at how much the coefficient of expansion of materials varies even over a limited temperature range of $-50°C$ to $+90°C$.

Another interesting sidelight is the fact that the fabricator of lead screws soon becomes convinced that a good master oscillator is the final answer in measurement of lead error. Besides being more accurate, it is more convenient for determining lead error than the methods more commonly used for inspecting such lead screws. For example, to use our previous illustration of an oscillator having a one megacycle coverage for one inch of travel, errors of a few millionths of an inch can be detected rather easily.

Where excellent temperature stability is required, the design engineer finds that many hours are required for acquiring proper data on the oscillator under test. There seems to be no short cut method for accelerating these tests since they are necessarily time consuming.

Oscillator development is a very interesting combination of many problems which seem to have no end. But of course it is necessary to take time off every once in a while and write a parts list. In case the reader hasn't had this experience, it is a diversion often experienced by engineering personnel under several pounds per square inch of pressure.

Huth to Lecture

The importance of radio in international affairs is emphasized by the fact that the New School for Social Research, 66 W. 12th St., New York City, has planned a special course in that field, which is scheduled to begin February 4th. The lecture series will be given by Dr. Arno Huth, formerly of Geneva, an expert on international radio. Dr. Huth authored the article, "Status of Broadcasting Overseas," which appeared in January *Tele-Tech*.

TV Engineers Available

For the assistance of manufacturers in the solution of specific problems, Kings Electronics Co., 372 Classon Ave., Brooklyn, N. Y., is making available the service of its engineers and consultants. The company manufactures television antennas, variable condensers, coaxial cable connectors, and microphone plugs and jacks.

MULTIPLIER CIRCUIT

(*Continued from page 79*)

The instantaneous voltage output of a polyphase rectifier may be represented by a Fourier series:

$$e_d = A_0 + A_1 \cos p\phi + A_2 \cos 2p\phi + A_n \cos np\phi + B_1 \sin p\phi + B_2 \sin 2p\phi + B_n \sin np\phi \quad (2)$$

where p = number of rectifier phases (refer to Fig. 4).

Rissik further shows that the harmonic coefficients are given by:

$$A_n = \frac{p}{\pi}\int_{-\frac{\pi}{p}}^{+\frac{\pi}{p}} \sqrt{2}\, E \cos\phi \cos n\phi \cdot d\phi \quad (3)$$

and

$$B_n = \frac{p}{\pi}\int_{-\frac{\pi}{p}}^{+\frac{\pi}{p}} \sqrt{2}\, E \cos\phi \sin n\phi \cdot d\phi \quad (4)$$

n in (3) and (4) equaling mp with m = any integer; to find the n^{th} coefficient therefore:

$$A_n = \sqrt{2}\, E \frac{p}{\pi}\int_{-\frac{\pi}{p}}^{+\frac{\pi}{p}} \cos\phi \cos mp\phi \cdot d\phi \quad (5)$$

$$= \frac{\sqrt{2}\, E\, p}{\pi(m^2p^2-1)}\left[2mp \sin m\pi \cos\frac{\pi}{p} - 2\cos m\pi \sin\frac{\pi}{p}\right]$$

$$= \frac{2\sqrt{2}\, E\, p}{\pi(m^2p^2-1)}\left[\pm \sin\frac{\pi}{p}\right]$$

$$= \frac{2}{n^2-1}\left[\sqrt{2}\, E \frac{p}{\pi} \sin\frac{\pi}{p}\right] \quad (6)$$

$$= \pm\frac{2E_d}{n^2-1}$$

$$B_n = \sqrt{2}\, E \frac{p}{\pi}\int_{-\frac{\pi}{p}}^{+\frac{\pi}{p}} \cos\phi \sin mp\phi \cdot d\phi \quad (7)$$

It immediately becomes apparent from an analysis of all the above that only harmonics that are a multiple of the supply frequency and/or the number of phases will be present in the output. Further, that their magnitude depends only on their order.

It may prove difficult to reconcile the statement earlier in this article that this multiplier "gives very pure wave form" with the discussion above. It must be kept in mind that the multipliers described consist of a polyphase rectifier and a wave shaping circuit.

In order to accomplish the desired wave purity a rule-of-thumb criteria is established; the bandwidth of the tank circuit, at the half-power points, should not exceed 10% of the desired harmonic frequency.

In Fig. 3 is shown a schematic of a quintupler. Conditions here are the same as in the tripler, except, of course, that the voltages are 72° apart. These two units can be cascaded to give 15F in the output. There should be a single stage voltage amplifier interposed between the two units, however, since the efficiency of these multipliers is quite low. This is readily understood from a study of Fig. 4.

In conclusion it should be mentioned that multiplication of over five in one unit will be difficult. The extremely fine phase angle shift required in such cases will present no small problem.

AUTOMATIC TV CONTROL

(*Continued from page 76*)

triggered synchronizing, and 5(b) shows the improvement gained by the use of automatic frequency and phase control under identical conditions. Fig. 6 shows the effect of a doorbell buzzer with a strong local signal applied to the receiver. In 6(a), with triggered sync, the horizontal lines are torn out by the interference signal somewhat destroying the picture detail. In 6(b) the same interference is shown by black horizontal lines. It is interesting to note the duration of the interfering pulse is about four microseconds, which can be estimated by the relative length of the black lines in 6(b) and the picture width. Probably the most gratifying result of this development is the reaction obtained from users of a considerable number of receivers equipped with this circuit. Consistent reports of trouble-free automatic syncronizing, with no disturbance of the line structure, in locations where triggered sync circuits have been unsatisfactory due to high interference signal levels, have proved that automatic frequency and phase control is a desirable feature for home television receivers.

CORRECTION

Through an unfortunate printer's error, the caption for Fig. 6 in Ralph Batcher's article on page 47, was misplaced. The correct caption should read: Fig. 6—Individual two-stage video amplifier, one of five used in distribution amplifier.

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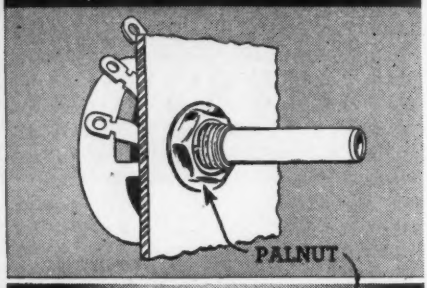

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AUTO-GAIN AMPLIFIER

(*Continued from page 36*)

common peak - limiting - amplifier ailment of "motorboating" can never occur in the CBS 1-A regardless of dynamic balance, since the automatic control voltage is not a function of the output voltage of the amplifier.

The level-control characteristics of the amplifier maintain the output level constant within 0.5 db for an input level increase of 12 db above the threshold value. This characteristic indicates that the CBS 1-A has a much higher compression ratio than most peak-limiting amplifiers currently in wide usage. From an operational standpoint, the amplifier will therefore maintain a higher average modulation level without overmodulation of an associated transmitter.

The effective recovery time of the amplifier depends upon the nature of the program material which causes automatic gain-reduction to occur. For single program peaks of relatively short duration, the CBS 1-A provides adjustable gain recovery on the order of 0.3 seconds, but should several program peaks occur in rapid succession, the effective recovery time is considerably lengthened by means of a special "anti-pump" circuit. This circuit reduces the amount and rate of change gain between the successively recurring peaks, thus minimizing the usual objectionable "pumping" of the program level. By means of this circuit, larger amounts of automatic gain-reduction may be employed with less loss of dynamic volume range.

The amplifier is designed to work from a source impedance of 600 or 150 ohms, and into a load impedance of 600 ohms, in accordance with the proposed RMA standards for audio facilities. The minimum input level which will cause gain-reducing action is —32 db.* The input level is adjustable in one db steps by means of a front-panel-mounted, 30-step, input level control. Normal output level at the verge of gain-reduction (and with zero loss in output pad) is +12 dbm. This level is adjustable in 0.2 db steps by means of a front-panel-mounted, 45-step, output level control.

*0 dbm = 1 mw, sine wave.

The CBS 1-A amplifier consists of two separate units designed for standard relay rack mounting. The amplifier unit requires 12¼ in. of rack mounting space, and the power supply unit occupies 10½ in. of rack space. The two units may be separated physically from one another as far as desired. Each unit has vertical-chassis construction, with ingeniously hinged front-cover panels which swing open 90°, exposing the interior of the chassis. These provide easy access to all components when making periodic adjustments, or when servicing the units in the rack.

Metering Methods

All controls and meters which are used in normal operation of the amplifier are mounted directly on the hinged panels, and do not need to be removed or disturbed in any way when adjusting or servicing the units in the rack. Several controls which are used only occasionally during adjustments of the amplifier are mounted on a sub-panel in the amplifier unit, and are exposed when needed by opening a separate, hinged cover panel.

A dc meter is provided on the front panel of the amplifier unit for (1) indicating the degree of automatic-gain reduction directly in db, (2) indicating the dynamic balance of the variable-feedback tubes, (3) measurement of tube plate currents, and (4) measurement of plate voltage. A panel-mounted rotary switch selects the meter function.

The power supply unit contains two separate regulated power supplies, which provide potentials of 250-volts positive and 250-volts negative, respectively. These power supplies maintain constant dc output voltages over a wide range of ac line-voltage variations. The front cover-panel of the power supply unit mounts a power switch and a red-jeweled pilot lamp. Adjustment of the dc voltage of the power supplies is accomplished by two controls mounted on a sub-panel in the interior of the power supply chassis. This sub-panel also mounts a 5-ampere power fuse. The voltage-controls and fuse are readily accessible from the front of the unit by opening the hinged front cover-panel.

LANAC—TWO-SIGNAL NAVIGATION SYSTEM

(*Continued from page* 53)

The GTC circuit, which is nearly always used in conjunction with gating, causes receiver gain to rise to normal slowly at the outset of each gated reception period, so that answers from nearby repliers will not produce excessively large signals on the display (such as circles on a PPI), and any echoes of the challenger's own transmissions will be suppressed. Several methods are used to achieve the desired results, all of them involving the periodic application of a positive waveform with a sloping leading edge. Typical gate and GTC waveforms and their combined effect on receiver gain versus time are illustrated in Fig. 9.

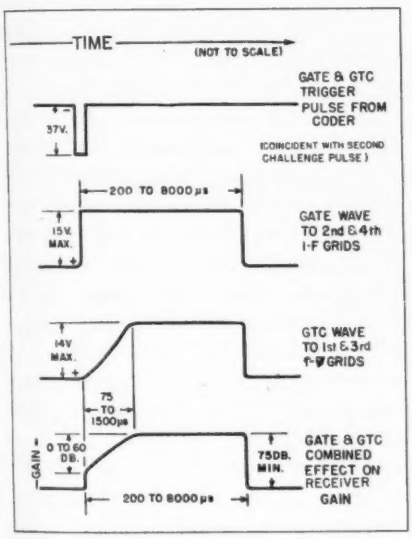

TIME
(NOT TO SCALE)
GATE & GTC TRIGGER PULSE FROM CODER
37V.
(COINCIDENT WITH SECOND CHALLENGE PULSE)
200 TO 8000 μs
15V. MAX.
GATE WAVE TO 2nd & 4th I-F GRIDS
14V MAX.
GTC WAVE TO 1st & 3rd I-F GRIDS
75 TO 1500 μs
0 TO 60 DB.
GAIN
75DB. MIN.
GATE & GTC COMBINED EFFECT ON RECEIVER GAIN
200 TO 8000 μs

Fig. 9—Gate and gain time control waves

The replier receiver employs both *automatic overload control* (AOC) and automatic volume control (AVC) to counteract jamming and to protect the decoder from overloading on too many signals at once. AOC prevents overloading by providing a sharply progressive gain reduction in the presence of "railing" (pulse-type jamming signals) and when the challenge-pulse recurrence frequency (in an area of high traffic density) reaches a dangerously high rate. AVC counteracts on-frequency c-w jamming, and helps reduce widepulse interference. These circuits are most conveniently considered as a single system, since they become active at a common threshold, and both affect the IF gain.

In the Model 1180 or 1168 replier, the AOC/AVC line is common to the grid returns of the first and fourth IF amplifiers, the detector diode plate, and the plates of a 6J6 AOC/AVC dual diode. With half of the 6J6 normally conducting, and the other half normally cut off, the AOC/AVC line potential is maintained almost at ground, and has no appreciable effect. Under jamming or overload conditions, however, this potential goes rapidly negative, biasing the two IF tubes and the detector diode toward cutoff to attenuate receiver gain.

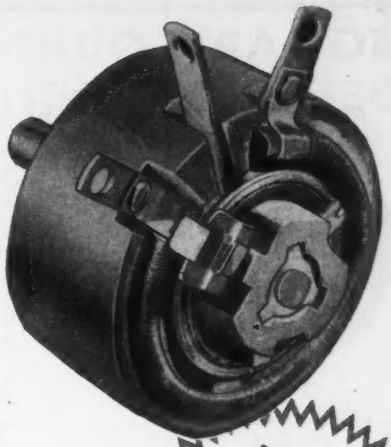
MEASURING V-2 VELOCITY

(*Continued from page* 59)

The value of cut-off frequency set up on the decade dials was about 5% lower than that corresponding to the desired final velocity. When the relay was first actuated, the preliminary cut-off impulse was forwarded to the cut-off transmitter to initiate the 8-ton stage. At the same time, a pair of condensers, marked "C" in Fig. 5, were removed from the frequency measuring bridge. The result was to increase the nul frequency by a factor of 5% above the reading on the dials. Of course, this caused the current through the polarized relay to resume its original direction. On its second operation, coincident with the rocket's attainment of desired final velocity, a second impulse was provided the cut-off transmitter to cause complete cut-off.

The cut-off transmitter, operating in conjunction with an airborne cut-off receiver, was a completely separate radio link. Upon reception of a suitably coded signal, the cut-off receiver actuated relays in the rocket to produce, first, jet reduction, and finally jet cut-off.

In this article no intention existed of discussing future possibilities of systems of the type described. But it does not seem unwarranted, on the basis of German results, to suggest that system engineers consider the possibility of utilizing Doppler technics as another of several tools applicable to the field of high velocity measurements.



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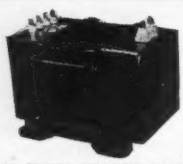

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LOW LOSS DIELECTRIC

(*Continued from page* 87)

power factor with frequency, both at room temperature and 85°C, are shown in Fig. 2. These measurements have been made by the Laboratory for Insulation Research, Massachusetts Institute of Technology, under the direction of Prof. A. von Hippel.

The linear thermal expansion of AlSiMag 243 follows an even line. This is an advantage for the designing of metal-ceramic seals. It is possible to select commercially available metals and glasses which "match" the thermal expansion of this material. Thus it is possible to make vacuum tight seals free from strains. Fig. 3 shows the expansion characteristics of AlSiMag 243, together with those of glass sealing alloy No. 49 and glass G-12.

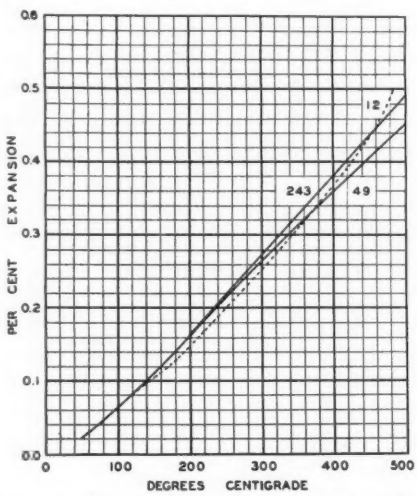

Fig. 3—Linear thermal expansion of G-12 glass, AlSiMag 243 and Alloy 49

Glass sealing alloy No. 49 is a 49% nickel-iron alloy having a nominal composition of maximum .1% carbon and 49% nickel, made by the Carpenter Steel Co., Reading, Pa. Glass G-12 is a Corning soft glass, commonly used in radio work and obtainable from Corning Glass Works, Corning, N. Y.

If a metal-ceramic seal that can be soft soldered is desired, it is possible to apply a metallic coating of silver directly to the ceramic. Such a metallic coating is sufficiently elastic to follow the dimensional thermal changes of the ceramic and the thermal coefficient of expansion of the metal need not match that of the ceramic. The permanently fused-on metal coating can be electroplated, tinned and soft-soldered to any other metallic surface.

Vacuum tight metal-ceramic seals also have been made successfully by fusing molybdenum or iron powder to the ceramic under a protective atmosphere. Such coatings have the advantage that they can be silver-soldered or brazed to metals and can be used at temperatures close to the fusion point of high temperature solder, which is around 1000°F.

In cases where a smooth surface which can be easily cleaned, is desired, a smooth glaze is applied to AlSiMag 243. The glaze is fired after the part has been vitrified at high temperature and is melted onto the surface at about 1000°C. Where extremely low surface resistivity under humid conditions is essential, a thin film of water repellent silicone compound can be applied by the use of General Electric Co.'s Drifilm treatment, or by treating the parts with Dow-Corning Co.'s Silicone compound No. 200.

Like any other ceramic material, AlSiMag 243 undergoes shrinkage during the firing or sintering process and this shrinkage is somewhat greater than normally experienced with other ceramics. Dimensional tolerances, therefore, have to be set slightly wider than those adopted for standard Steatite parts. At present it is possible to hold these tolerances to plus or minus 1½% of the nominal dimension, but in no case less than plus or minus .007 in. without grinding the parts after the sintering process.

AlSiMag 243 already has found wide applications in the electronics field where dielectric losses are the prime consideration in selecting an insulating material. Concentric line spacers for insulating high frequency cables, stand-off insulators, jackets for vacuum tubes are just a few applications where AlSiMag 243 is used successfully.

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Electric Furnace Study of the MgO-SiO System. Journal American Ceramic Society, Vol. 25, No. 11, July 1942, pp. 294-310.

Ralston Russell, Jr. Zircon Porcelain. Westinghouse Engineer, May 1946.

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Table of Dielectric Materials. Laboratory of Insulation Research, M.I.T. National Defense Research Committee Report V. February 1944.

LOUD SPEAKER

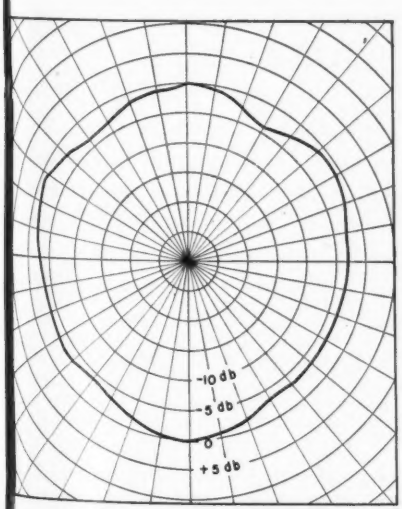
(*Continued from page* 63)

which is slightly more than the maximum movement it can experience under peak audio power.

Reproducing systems which lack bass and have a rising frequency characteristic, reaching a peak at about 3000 cycles and then tapering off with little output about 6000 cycles, have a quality of speech which is clear and crisp, and have the maximum ability to penetrate surrounding noises, such as loud conversation, engine noises, and the general conglomeration of sounds that may exist at the location of the listener. Therefore this type of response curve has been incorporated in the design.

Radiation in this speaker is distributed through 360° and has the shape of a toroid expanding outward. Because of the bending wave front, the diffraction phenomenon is pronounced and hence the areas at the center, and also above and below the center, receive energy. Along the center of the axis, at right angles to the plane of the mouth opening, there is a focal point of diffracted waves. This diffraction characteristic develops the original direct circular wave into a spherical wave expanding outward in all planes.

Polar curves traced through 360° in two planes, show that there is



Directivity pattern of model MSR University speaker at 1000 cps

as much energy in the vertical plane as in the horizontal. Except for some slight obstructing effects caused by the physical presence of the housing, the speaker is very nearly a point source radiating in all directions.

Besides its obvious adaptability for marine use, this speaker can be used in other industrial capacities. It will operate under conditions of high humidity in laundries, dye houses, or other industries involving moisture hazards, and also in railroad yards, on platforms in locomotive cabs, or along the right of way. It is immune to coal dust, live steam, dirt, or extreme climatic conditions and is useful where dust or gases in the atmosphere make an "explosion proof" speaker necessary, as in powder factories, flour mills or mines.

EXHIBITORS AT IRE

(*Continued from page* 55)

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Hallicrafters Co., 2611 Indiana Ave., Chicago
Frederick Hart & Co., 350 Madison Ave., New York
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Insl-X Co., Inc., 857 Meeker Ave., Brooklyn 22, N. Y.
Instrument Electronics, 253-21 Northern Blvd., Little Neck, L. I.
Instrument Specialties Co. Inc., Little Falls, N. J.
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(*Continued on page* 132)

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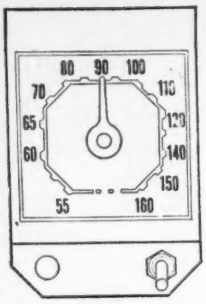

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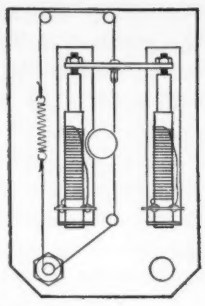

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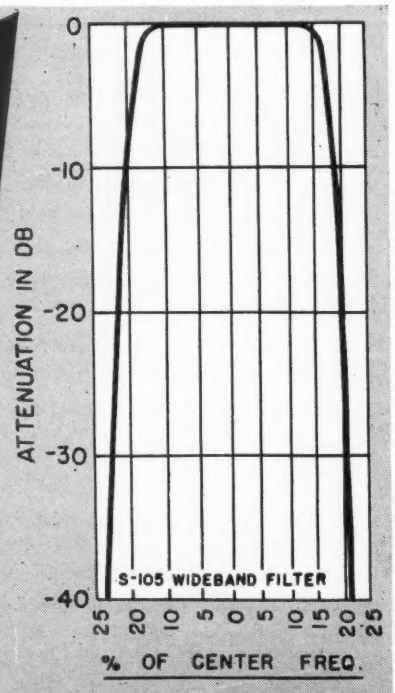

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Kurman Electronics Corp., 130 Clinton St., Brooklyn, N. Y.
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PERSONNEL

Kenneth A. Norton has been appointed chief of the recently established frequency utilization research section of the central radio propagation laboratory at the National Bureau of Standards. An authority on radio wave propagation, he rejoins the bureau's staff from the War Department, where he served as a consultant in radio propagation to the Chief Signal Officer and as assistant director of Dr. W. Everitt's operational research group.

K. A. Norton

G. C. Kuczynski

Dr. George C. Kuczynski has been appointed to the research staff of the Sylvania Electric Metallurgical Laboratory, Bayside, N. Y. He was the 1945-6 recipient of the Baldwin - Southwark Fellowship award for fundamental work on strain gage wires, and prior to joining Sylvania was a special instructor in the application of quantum mechanics to the electron theory of metals at MIT.

Dr. Courtnay Pitt has been appointed economist of Philco Corp., Philadelphia, to be in charge of the division of economic research. He was formerly a member of Princeton University faculty, and joined Philco in 1941, where he has been in charge of the preparation of all reports to stockholders.

Robert W. Larson has been appointed assistant to the director of the General Electric Research Laboratory at Schenectady, N. Y., to aid in planning and operating the new laboratories being built in nearby Niskayuna. He joined GE in 1922, and has held various posts including chief technical aide and deputy chief of Division 15, National Defense Research Committee, under Dr. Suits as chief.

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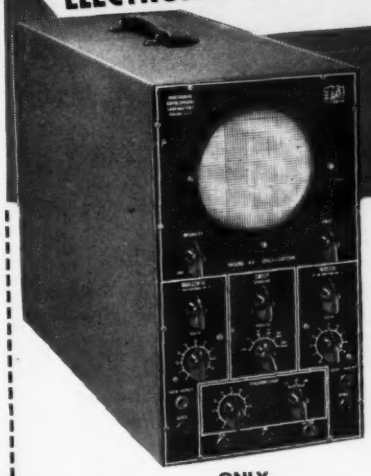

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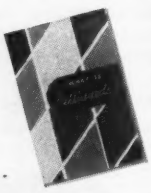

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Ernest E. George has been appointed engineer of the metallurgy division of the General Electric chemical department. He joined GE in 1933, and was associated with the Schenectady works laboratory from 1935 to 1945, when he became a member of the Carbon Products Engineering division.

William F. Cotter, who played an important part in the development of the point-to-point duplex telephone and ship-to-shore telephone systems, has been appointed chief engineer for the Scott Radio Laboratories, Inc., Chicago. He had been associated with Stromberg-Carlson since 1935, first as chief radio engineer and later as radio consulting engineer.

W. F. Cotter

T. B. Moseley

Thomas B. Moseley has been appointed broadcast sales engineer for the southwest area for the Collins Radio Co., Cedar Rapids, Ia. Recently he was secretary-treasurer and chief engineer for the International Electronics Corp., Dallas, and was chief radio engineer, Signal Office, Headquarters 8th Service Command during the war.

Garrard Mountjoy has resigned as president of Electronic Corp. of America, Brooklyn, N. Y., in order to devote his full time to his work as a consulting engineer to the radio industry. Samuel J. Novick has resumed the presidency of the company, which he founded and managed until April, 1946.

H. I. Romnes, who has been in engineering and research work in the Bell System for the past 18 years, has been appointed radio engineer of the American Telephone and Telegraph Co., New York. In his new position he will head the radio section of the company's engineering division, succeeding **Francis M. Ryan,** who previously had been named radio coordinator.

Dr. Charles M. Slack has been appointed director of research for the Westinghouse Lamp Division, replacing **Dr. Harvey C. Rentschler,** who is approaching retirement. Dr. Slack joined the research department at the Bloomfield plant as a physicist in 1927, and became assistant director of research in 1943. **Dr. John W. Marden,** who has been assistant director of research in charge of the development of rare metals, has been appointed manager of a newly established molybdenum department at the Lamp Division.

Emil F. Hembrooke, director of equipment and engineering for Muzak Corp., New York, N. Y., since 1945, has been elected vice-president. He was chief engineer for Muzak from 1941 to 1943, and previously served with Western Electric and Electric Research Products, Inc.

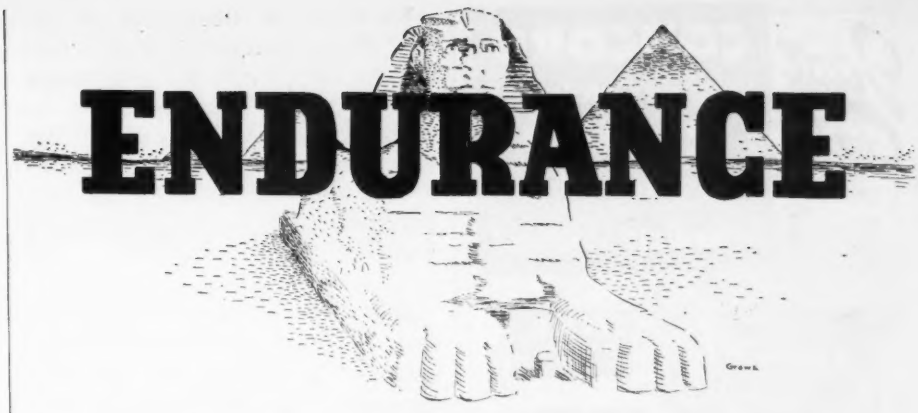
Maurice J. Hoke has been appointed chief engineer of the crankshaft and camshaft divisions of the Ohio Crankshaft Co., Cleveland, and will be in charge of all processing and development work in these two divisions. He joined Ohio Crankshaft in 1944 from the Consolidated Vultee Aircraft Corp., where he was chief tool engineer.

Edwin Moran, formerly vice-president of Sperti, Inc., has been appointed to head the industrial and commercial activities of Hanovia Chemical and Manufacturing Co., Newark, N. J.

Jennings B. Dow, formerly director of electronics of the Navy department's Bureau of Ships has established his own business as a consultant in the field of electronics. His offices are at 726 Jackson Place NW, Washington.

Herbert C. Guterman has been elected senior vice-president and general manager of Arma Corp., Brooklyn, N. Y., manufacturer of precision gaging and sorting equipment.

Dr. I. N. Zavarine has joined the metallurgical research staff of Sylvania Electric Products, Inc., Bayside, L. I., N. Y. For 10 years until 1940 he was a professor of physical metallurgy at MIT.



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Raymond M. Obermiller of the FCC engineering staff, who before the war was associated with Globe Wireless, Ltd., has returned to Globe for a New York post. He will be responsible for Globe communications activities in the New York area with offices at 42 Broadway.

Emil Reisman has been appointed chief engineer of Resistance Products Co., Harrisburg, Pa. He was formerly with International Resistance Co. as development engineer on fixed and variable resistors, and high voltage and high frequency resistors.

Dr. Edwin E. Whitehead, recently appointed professor in the Illinois Institute of Technology's electrical engineering department, has been appointed secretary of the Midwest Power Conference, to be held next spring. Dr. Whitehead has been associated with the Duquesne Light Co. for the past fourteen years as research supervisor, operating engineer and investigating engineer.

David J. Farber has joined the National Association of Broadcasters, Washington, D. C., as research economist and assistant to the director of employe-employer relations. Associated for two years with the National War Labor Board, he will be responsible for research activities in the general field of labor economics, including wages, collective bargaining, etc.

Dr. Eugene Mittelmann has resigned as director of electronic research and development for the Illinois Tool Works, Chicago. He will organize his own research and development organization devoted to the applications of electronics in industry with headquarters in Chicago at 427 West Wrightwood.

Robert E. McCoy, recently associated with the radio direction finding branch of the Signal Corps Engineering Laboratories, has left that organization to become an independent consulting engineer. He will cover the field of electrical design and theory, with particular emphasis on electronic equipment. His headquarters will be in Gresham, Oregon.

Paul W. Polk has been elected vice-president and manager of the Threadwell Tap and Die Co., Greenfield, Mass., which is an independent subsidiary of the Sheffield Corp., Dayton. Although continuing as a director and officer of Sheffield, he will devote all his time to his new responsibilities at Threadwell.

Alfred T. Johns, former production manager at Meck Industries, has joined Lear, Inc., Grand Rapids, as production manager of their home radio division. With seventeen years' experience in the radio industry, he was also associated with the Sparks Withington Co. and with International Detrola Corp.

Albert D. Stern, vice president in charge of sales for Frederick Hart & Co., Inc., Poughkeepsie, has resigned from the firm. He plans to form his own company which will manufacture and distribute film and wire sound recording devices for commercial and home use to meet the domestic and export demand.

Peter J. Menan, previously associated with the development and research and product design departments of IRC, has been appointed manager of Resistance Products Co., Harrisburg, Pa.

H. H. Watson, who joined GE's testing department in 1922, has been appointed standards engineer of the appliance and merchandise department, General Electric Co., Bridgeport. He was formerly designing engineer of the wiring device division.

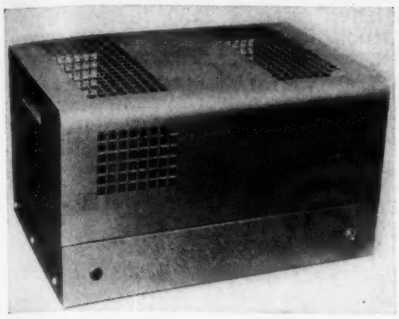
Crystal Control Tubes

Editor *Tele-Tech*: One of your readers has written me in regard to my article in the January issue of *Tele-Tech* entitled "Crystal Control for Stability in VHF Receivers." He points out that 6AG5 tubes are not suitable for the circuits for figures 3A and 4 because they have no separate suppressor connection. I therefore wish to correct this error. The proper tubes are 6AC7, 6AH6 or 6AU6. In addition, in Fig. 2, the 6A7 cathode connection should be completed to the center tap of the tuning inductance of the top push-button.

Norman L. Chalfin

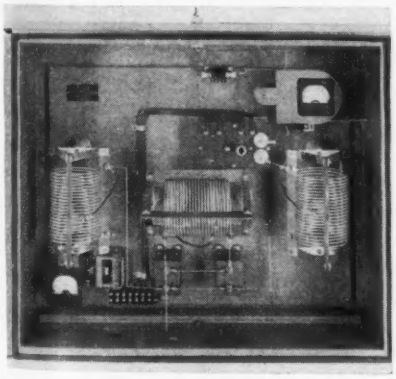
WHAT'S NEW

(*Continued from page* 104)



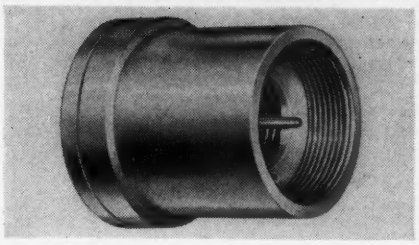
HIGH POWER AMPLIFIER

Having high power output with good regulation and a response flat within 1 db from 20 to 20,000 cps, two booster amplifiers, G050 and G0125, are capable of delivering 50 and 125 watts respectively. Two type 807 tubes in pushpull with multistage inverse feedback are used in the output stage. Input impedance is 500,000 ohms, with provision for balanced input on telephone lines. Tube regulated screen supply, standby relay provision, and oilfilled input filter capacitor are some of the features of these amplifiers.—*David Bogen Co., 663 Broadway, New York 12.*



ANTENNA TUNING UNITS

Similar in all respects except their power handling capacity the RT-1,000 antenna tuning unit is suitable for AM broadcast stations from 250 watts to 1 kw power, while the RT-5 unit is for AM stations from 5,000 to 10,000 watts power. Antennas of widely diverse characteristics and directional antenna systems may conveniently be matched to concentric or open-wire transmission lines by means of these units. Consisting primarily of a single "T" section low pass filter network, the components are housed in a sheet metal cabinet which is completely weatherproof. The antenna current meter can be read through a glass window in the front door.—*Broadcast Equipment Div., Raytheon Mfg. Co., 7517 N. Clark St., Chicago 26, Ill.*



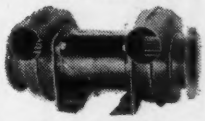
MIDGET MICROPHONE

Accurate measurement of sound pressures for scientific studies of sound intensities is made possible through this Midget condenser microphone which is suitable for laboratory or commercial use. When used with a suitable preamplifier the output of the unit is about 59 db above 1 volt/dyne/cm^2. Response is flat within 1 db from 100 to 7,000 cycles and within 3 db from 60 to 10,000 cycles. Acoustic intensities of 1200 to 1400 dynes/cm^2 can be measured with the unit, which uses a diaphragm stretched from .0005 dural sheeting and has an electrostatic capacity of approximately 35 mmfd.—*Kellog Switchboard and Supply Co., 6650 S. Cicero Ave., Chicago, Ill.*

HIGH POWER AUDIO SOURCE

A series of 1000 watt audio amplifiers for vibration testing of large structures has recently been completed. Also adaptable as a variable frequency power source for electrical testing, the units have low harmonic distortion and frequency deviation from 25 to 1500 cycles. Overall gain of 96 db at an input impedance of 100,000 ohms is available. Hum level is held 48 db below full output. Overload and time delays as well as an output limiting circuit are provided. Tubes are air-cooled by means of blowers. A circuit interlocking door system protects the operator. Extended frequency and power ranges are available.—*Thordarson Electric Mfg. Div., Maguire Industries, 500 West Huron St., Chicago 10, Ill.*

BARGAINS IN
Communications & Electronics Supplies



DUAL BLOWER
Blows 200 CFM; 110 V AC; Ideal for cooling large tubes or exhaust for lab or Photo Darkroom. Guaranteed.

CW3 RECEIVER **$15.95**

A fixed freq. receiver (1100 KC to 16,500 KC) xtal controlled superhet with BFO and AC power supply; 110V, 60 Cy; coils can be furnished in any of the following groups: 1100-2100 KC; 3500-6100 KC; 5600-10,000 KC; 9400-16,500 KC; complete with add. set of tubes and one set of coils, less xtal. Xtal available on request—specify operating freq. **$32.50**

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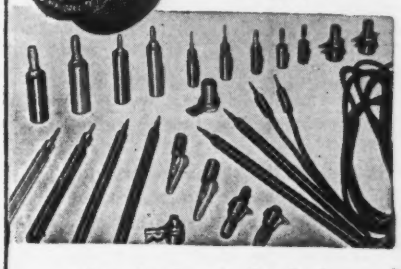

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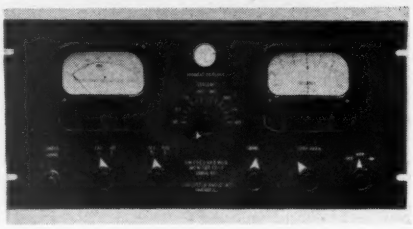
(*Continued from page* 137)

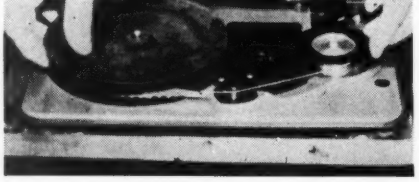


MODULATION MONITOR

Combining a frequency meter and modulation indicator in one convenient unit the Doolittle FD-11 monitor is for use on the 88-108 broadcast FM band. The center frequency deviation meter is direct reading with an accuracy of better than .0003%. Modulation up to 133% (75 kc as 100%) is indicated with an accuracy of ±5% at any reading. The unit can be calibrated with WWV directly by use of an external receiver. Made for rack mounting the instrument operates on 110 V, 60 cycle, ac.—*Doolittle Radio Inc., 7421 So. Loomis Blvd., Chicago 36, Ill.*

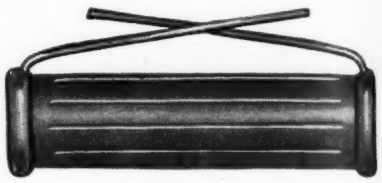
THREE-CHANNEL MIXER

Two additional microphone inputs may be added to any PA amplifier by means of the Max-Mixer which provides three volume controls for controlling the level of 1 to 3 microphones. The unit is housed in a cast aluminum case which shields the network and is equipped with 6 ft. of shielded microphone cable. A screw-on type plug is provided with a phone jack adapter for use on amplifiers with either type of input.—*Special Products Co., Silver Spring, Md.*



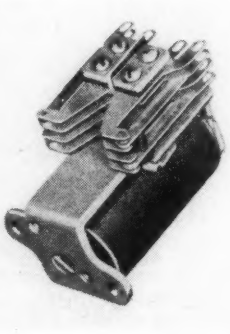
WIRE RECORDER

Available separately for use in phonographs and radio-combinations this low-cost wire recorder has a frequency response from 40 to 8,000 cps and permits one hour of continuous recording. Consisting of a recording turntable which will also accommodate standard recordings, and an Astatic microphone, the St. George wire recorder is furnished with a 7200 ft. wire spool, which is suitable for re-recording. Rewind is five times the speed of recording. A separate recording amplifier is required capable of producing 12 volts output across 500 ohms and having a gain of approximately 112 db. It can be furnished with the recorder.—*Milo Radio & Electronics Corp., 200 Greenwich St., New York 7, N. Y.*



METAL FILM RESISTORS

A unique method of longitudinal grooving makes possible the non-inductive Nobleloy type X metal film resistors, available in resistance ranges from ½ to 50,000 ohms with an accuracy of 1%. The units are efficient for high frequency applications and heavy loads in sizes ½, 1, 2, and 5 watts. For dc circuits resistance values ranging from ½ ohm to 50 megohms with an accuracy of 1% are available. The metal resistance film is fired upon a ceramic tube and coated with high temperature vitreous enamel. This process makes for stable resistance characteristics, low noise level and high overload rating.—*Continental Carbon, Inc., 13900 Lorain Ave., Cleveland, Ohio.*



MULTIPLE POLE RELAY

Designed for industrial and communication applications, R-B-M Series No. 98330 midget ac multiple pole relay is available for standard voltages from 1½ to 220 volts for 60 cycle operation. Contacts can be supplied to 4 poles, normally-open, normally-closed, or double-break with a rating of 3 amps. at 24 volts ac. The relay is also available in single pole, normally-open, double-break contact with 10 amps. rating at 115 volts ac.—*R-B-M Div., Essex Wire Corp., Logansport, Ind.*

NEW BOOKS

Telecasting and Color

By Kingdon S. Tyler. Published 1946, Harcourt, Brace and Co., 383 Madison avenue, New York. 213 pages with 54 illustrations, (mostly photos) of current television equipment. Price $2.75.

The author (a construction engineer with CBS Columbia Broadcasting System) presents a review of the CBS color television system, giving a simple description of the fundamental process of transmitting pictures followed by a non-technical description of the problems attending the sequential method of color synthesis.

Basic Mathematics for Radio Students

By F. M. Colebrook (of the Radio Division, National Physical Laboratory). Foreword by Prof. G. W. O. Howe. Published for "Wireless World" by Iliffe & Sons Ltd., Stamford St., London SE 1. Size 4⅜ in. by 7 in., by 7 in. (F 8vo), 270 pages, 77 diagrams. Price 10/6 net.

In this book the author has selected in each branch of the radio field those fundamental ideas which experience has shown to be necessary and useful. Written primarily for radio students it is useful to engineering students of other subjects. Chapter contents include: Elementary algebra, Indices and Logarithms, Equations, Complex Numbers, Continuity, Limits, Series, (geometrical and trigonometrical), Differential and Integral Calculus and a final chapter on the application of mathematical ideas to radio.

Directional Antennas

By Carl E. Smith, E.E. Published by Cleveland Institute of Radio Electronics, Terminal Tower, Cleveland, Ohio. Leatherette, looseleaf binding, over 300 pages 8½ x 11, more than 15,000 patterns. Price $15.

A systematic treatment of directional antenna patterns containing an elaborate group of antenna patterns obtained with the aid of an electromechanical directional-antenna pattern calculator designed by the author. This machine automatically draws the horizontal pattern of an array containing two to four elements with the possibility of adding as many more elements as desired. It also automatically draws field-intensity contours at various elevation angles, to give the vertical pattern in any direction from the antenna system. The book also contains a comprehensive compilation of design equations for the use of the communication engineer engaged in broadcast antenna design to meet allocation requirements.

The first section gives, in comparatively simple form, the fundamental properties of directional antennas, and develops the design equations and shows graphical methods for the solution thereof. It then applies these generalized equations to determine pattern shape and size, and finally illustrates with 568 patterns, covering spacings up to four wavelengths, and additional detailed charts for critical conditions in smaller steps with separations up to one wavelength. Additional, (close to 15,000) directional antenna patterns for 229 layout arrangements of 3 element combinations are shown analyzed for various separations, and relative phasings.

The book provides an excellent handbook in any broadcast station reference library and a reference book for consulting and broadcast station engineers.

Engineering Handbook of the National Association of Broadcasters

432 Pages (8½ x 11) in ring binder. Published by N.A.B., 1760 N St., (NW) Washington 6 D. C. at $10.

Herein has been compiled a group of selected papers covering regulations, operating procedures and design problems associated with broadcast station operation. The material, largely in the form of curves, tables and charts, covers such subjects as FCC Standards of Good Engineering Practice, directional antennas, field surveys, transmitter operation and maintenance, transmission lines, radiation characteristics, studio controls and practices, and others.

Principles of Radar

By members of staff of Radar School M.I.T. Second Edition. Published 1946 by McGraw-Hill Book Co., New York. 887 pages (offset). Price $5.00.

A textbook used in training courses on the principles and applications of radar, given to members of the Armed Forces at the Radar School of MIT. The second

(*Continued on page* 140)

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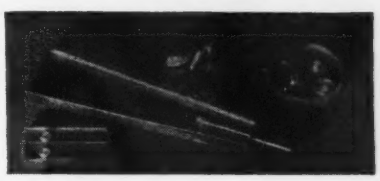

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edition brings the subject matter up-to-date, and adapts the presentation to a wider group of readers. The book begins with a brief description of the components and functions of radar systems and a detailed discussion of typical system components. Emphasis in the treatment of circuits is upon quantitative analysis directly from tube characteristics and physical principles.

Ark-Les Forms Electro

Ark-Les Switch Corp., Watertown, Mass., which has produced rotary snap switches and multiple rotary switches, has completed the organization of a new company to take over that portion of its business. The new organization will do business as the Electro Switch Corp., and will have headquarters in Weymouth, Mass. Head of the new company is Archie T. Morrison who will be its president and treasurer. Interested financially in the new organization are several officers of the Ark-Les Co., including president M. F. MacNeil, treasurer and chief engineer, H. W. Batcheller, general sales manager G. C. Barry and New York representative Bruno H. Ahlers.

Pennsylvania's State Police Radio Net

Following the lead of New York State, the Pennsylvania State Police organization has completed arrangements for the equipment and maintenance of its State system by the Bell Telephone Co. of Pennsylvania. The first 250-watt land station has been put in operation and it is expected that eventually the complete system will include 73 land stations, and 250 mobile units, each to be installed in a patrol car. Eighteen of the 250-watt transmitter-receivers will be located on hilltops and remotely controlled.

Fifty kw FM Station

Approval has been given by FCC for the erection of a 50-kw FM transmitter at the San Bruno, California, plant of Eitel-McCullough, Inc. Equipment, which has already been designed, includes a pair of Eimac 3X10000A3 triodes in the final amplifier driven by two 3X2500A3 triodes which are in turn driven by four 4X500A tetrodes in push-pull parallel. The modulator is of the Armstrong, dual-channel type and was manufactured by REL, Long Island City, N. Y., all other gear being manufactured in the laboratories of Eitel-McCullough.

Later in the year the transmitter will be moved to the 3848-ft. top of Mount Diablo, about 30 miles airline from San Francisco.

Farnsworth RR Antenna

It was a Farnsworth antenna installed on a Detroit, Toledo and Ironton locomotive in the DT&I Flat Rock, Michigan, yard, which appeared on page 80 of the last issue of TELE-TECH. The illustration was one of those appearing in the article by Joel Peterson under the heading "Railroads Plan Greater Use of Radio for Communications." Through an unfortunate error, the photograph was wrongly captioned.

With Two DI-ACRO BENDERS

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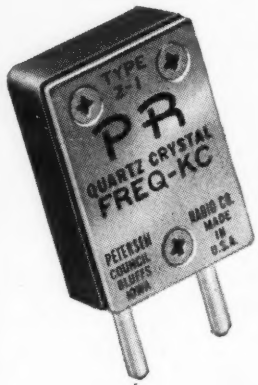

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PR Precision CRYSTALS

TELE-TECH

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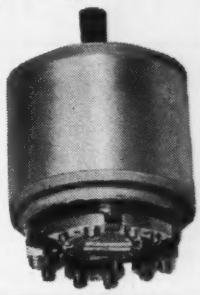
While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.

"TAB"

That's a Buy

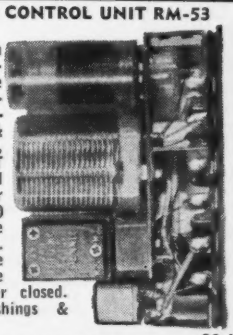
New Selsyns Type XXI, AC



SYNCHRONOUS REPEATER 115V 60cy —Made for Gunfire control; Guaranteed Ordnance Insp; Hi-accuracy; Continuous duty. Packed for overseas shipment, complete with Insp Calibration report. Per pair $7.95

BASIC KIT 3" C'RAY SCOPE—TRANSF. NAVY INSP. PRI 115V/60cy, SEC 1320V & 750VCT/110 ma, 5V/3A, 2.5V/3.25A, 6.3V/2.75A & High & low Voltage Rectifier tubes, choke, Resistors, oil condsrs. & 3BP1 tube.. $16.95
1N34 GERMANIUM CRYSTAL NEW GTD... 1.39
TRANSF 1200VCT/350ma, Pri 105-120V/50-60cy CASED 6.95
Electronic VOM—S.C. I-107-F COMPLETE.. 24.60
TRANSF cased S.C. Cont Duty, PRI 200 to 240 & 440V 50/60cy, SEC 3800VCT/6KV/2.7 AMPS ($365) 45.00
TRANSF CASED PRI 105 to 250V/50-60cy, SEC 2240VCT 500 ma, 12V/4.5A/19.2V/2.5A, 2.5V/10A, CASED GTD 11.50
NAVY SP 3" SYNCHROSCOPE NEW COMPL. 59.50
CRYSTAL STD 200KC ±10cys—Vacuum.... 5.95
DYNAMIC MICROPHONE 20' CABLE D17334D-A 9.95
Pri-Transf 230V input 117/112/103/93V/7a 19.95
CHOKE CASED 50Hy/125ma CHT NAVY... 2.50

NEW REMOTE CONTROL UNIT RM-53 (RC-261)



For voice operation of transmitter distances up to ½ mile from radio set—Complete with manual—Contains PL55 & PL68 cords & plugs, jacks, Mallory 4PDT switch. Two 4mfd oil condsrs. Transformer multi-tap UTC-600 ohmCT line to G, line to 150 or 250 ohms. KURMAN sensitive 4MA Relay DP one normally open, other closed. Toggle switch, bushings & water proof box.
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New Bulletins

INDUCTANCE TUNING

A technical information bulletin on the Mallory Inductuner has been issued by P. R. Mallory & Co., Inc., Indianapolis 6, Ind. Providing infinitely variable inductance tuning for all television, FM and other stations from 44 to 216 mc within range of the receiver, the tuner covers the entire band in 10 turns of the shaft, which may be motor driven or rotated by hand.

RECORDING MATERIALS

The increasing use of photography for the recording of irregular, recurring, and transient phenomena has led to the development of a wide variety of photographic recording materials for practically every type of recording instrument. The significant properties of these materials are listed in a 44-pg. data book published by Eastman Kodak Co., Rochester 4, N. Y. Besides including data on 13 types of recording materials the booklet describes in detail processing procedures and equipment, as well as recording technics for string galvanometers, mirror galvanometers, and cathode ray oscilloscopes. A thumb index facilitates the location of data sheets.

Microphones and Pickups

With emphasis placed on readability and imparting detailed information on applications, technical data, construction, and design, the 1946-47 catalogs of The Shure Bros., 225 W. Huron St., Chicago 10, Ill., describe a variety of microphones and pickups. Catalog 155 illustrating their line of microphones also carries an article on "How to Select the Proper Microphone" covering requirements, types, polar response, characteristics and frequency response. Catalog 156 shows the line of "Glider" crystal phonograph pickups and lever-type cartridges. It features an article on "Facts You Should Know About Pickups."

BROADCAST SPEECH EQUIPMENT

Subdivided to cover speech equipment, remote amplifiers, speech input consoles, etc., the new Collins speech equipment and accessories catalog, prepared by Collins Radio Co., Cedar Rapids, Iowa, facilitates selection of individual components or integrated over-all systems. Accessories such as mixing panels, program equalizers, relay panels, turntables, monitoring, and measuring equipment have been added to the 40-pg. catalog. Also new are a line of standard connectors, AM and FM monitors, noise meters, an AM frequency deviation monitor, and a line of all steel console desks.

FM BROADCAST EQUIPMENT

There are now twenty new FM stations on the air with REL transmitters, which are described in a 16-pg booklet published Radio Engineering Laboratories, 35-54 36th Street, Long Island City, N. Y. Bulletin 5015 outlines the services of the "FM Broadcast Engineering Clinic" and lists the stations equipped with REL equipment. Prices and delivery schedules are included for the model 549, 518, 519, 520, and 521 transmitters, model 600 modulation monitor, model 603 speech input console, as well as antennas and accessories.

VOLUME CONTROL GUIDE

Consisting of a collection of cards printed on both sides with a cross-index of corresponding type numbers in numerical order of four volume control manufacturers, this new volume control cross-index guide facilitates selection and interchange of the most popular control brands. The guide may be had from Clarostat Mfg. Co., Inc., 130 Clinton St., Brooklyn 2, N. Y.

AMATEUR TUBE DATA

Selection of electronic tubes for amateur radio applications is facilitated by the price and data sheet ETX-19 issued by the Tube Div., General Electric Co., Schenectady. Technical information and operating data on over 30 tube types are presented in precise form.

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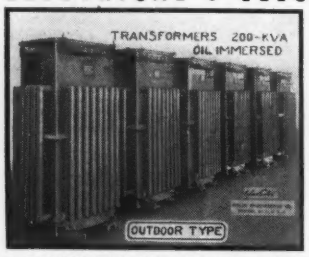

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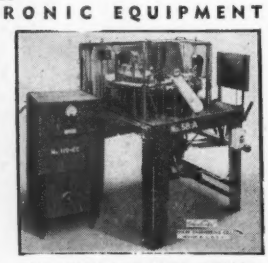

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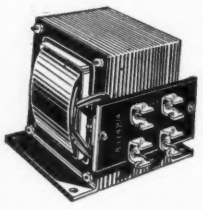

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